POWER

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Efficiency and Purchasing Power

TEDDY ROOSEVELT was against monopoly. Consolidation tends toward monopoly. When two concerns merge they do not need both presidents so one of them is taken off the payroll. The same thing applies to the treasurer, secretary, chief engineer and so on down the line, to and including the operators. This reduction in wages is reflected in the purchasing power of the country. In the extreme case we would have one company with one set of officers and the rest of the people would have the purchasing power only of workers. As we approach this condition, our purchasing power drops off. Just where do wages and purchasing power balance to produce the greatest good for all? Maybe Roosevelt knew more about this than we realize.

From this point of view every labor-saving machine or process, every movement in the direction of the elimination of waste or improved efficiency which effected a reduction in the man-power necessary to do the work of the world in the commonly accepted working time and with the number of willing and able workers available would be an economic misfortune. Loafing, sabotage, and "conscientious withholding of efficiency" would be commendable practices.

Everything that goes into the cost of living is reducible to terms of human labor. The more efficiently labor is employed the greater the purchasing power of a man-hour should be. If labor is employed unnecessarily, inefficiently or wastefully the money to pay for it must come from the consumer. And, by-and-large, the consumer is the worker himself when "worker" includes all those who exercise human application and effort for pay.

If each were given a chance to do that part of the world's work for which he is best adapted, if the reward of labor were based upon actual service or production, and price to the consumer based upon cost plus a fair profit, involuntary employment would be unknown, the number of man-hours that each would have to contribute to keep himself fed, clothed, sheltered, amused, and cultivated would be a minimum, and living would have more of leisure and stability, and less of worry and hazard for everybody.

Idealism — yes. Unattainable — maybe. But is it not better to strive toward such an intelligent regimentation of the results of research and invention and the rationalization of industrial and commercial processes than deliberately to make the work of the world harder in order that everybody may have a job?

F. R. Low

EDITORIALS

The World Power Conference

WHAT better expression of the meaning of power and of the ideals to which power engineers dedicate themselves than the words of Herbert C. Hoover while Secretary of Commerce.

He referred to power and electricity, a form of its application . . . "the greatest tool that has ever come into the hands of man. The degree to which we use this tool as a substitute for manual labor will largely determine the rate of our industrial and social progress. . . . Through more power we shall make a still greater saving in labor, shall increase the product of labor and shall lessen the burden on labor."

Engineers the world over are continually striving to find better and more efficient ways to utilize this tool, power. Progress is rapid; new methods for converting energy into useful work are occupying the best minds everywhere.

Power development not only interests the technician, but is of moment to the financier, the business man and the worker.

So the Second Plenary World Power Conference to be held in Berlin June 16 to 25 has an added significance for those who will, in the fullest sense, appreciate its purpose and place in world affairs.

Concerning Diphenyl

FOR SEVERAL years past it has been generally understood that extensive research was being carried on with diphenyl, a derivative of benzol. Rumor had it that this concerned the use of diphenyl as the high-temperature medium in a binary cycle for power generation. The facts, now released, show this rumor to have been erroneous. The investigations thus far have been directed toward ascertaining the properties of this substance, including its latent heat, specific heat, densities and vapor-pressure curve. A boiler has been built and is now in successful operation for temperature control in one of the large refineries.

Commercial diphenyl, which can now be marketed for thirty cents a pound, as compared to forty dollars a pound a year ago, has a melting point at atmospheric pressure of 170 deg. F., boils at 492 deg., and has a critical temperature of 980 deg. Furthermore, it has operated at 900 deg. for 500 hours with no evidence of decomposition and without attacking the metal of the container. Tests are now under way to determine accurately its limiting temperature.

Because of its high boiling point and low vapor pressure at elevated temperatures, diphenyl should prove an ideal heating medium and find its widest use in controlling the temperature of industrial processes.

Although further development may show its adaptability to the binary cycle, present indications are that it offers more immediate possibilities, in the power plant field, as a medium for interstage steam reheating. This would eliminate the reheat boiler and make it possible to reheat to higher temperatures than where steam reheating is now employed. Studies are being made with a view to such application.

Idle Bleeder Steam Service—Why?

ALTHOUGH the advantage of bleeding steam from a turbine to supply process steam for factory uses is well known among engineers, some extraction turbines are operating with the bleeder mechanism idle; while process steam is supplied through reducing valves.

Under certain circumstances, such as when changes to process require steam pressures higher than can be supplied from the extraction turbine, it becomes necessary to install reducing valves. But this does not necessarily mean that the use of bled steam must be discontinued. Factories require considerable quantities of low-pressure steam for building and water heating. The economy gained by using extraction steam for these purposes will generally justify considerable rearrangement of piping

in order to separate high- and low-pressure process-steam mains.

Neither is it necessary to discontinue the use of bled steam merely because more steam is required for process than the turbine can supply. A reducing valve and bleeder mechanism can be made to operate successfully in parallel.

Other excuses for not using extraction steam are met. Mostly, they indicate mistaken notions. When equipment for improving plant economy is available, why not use it to the full?

The Human Element in Elevator Service

IN A MODERN skyscraper building the public more intimately contacts with the elevator service than any other. It is the one that contributes most to their convenience and comfort. For this reason it should be made as efficient as possible. Tenants may excuse temporary defects in other building services, but they expect elevators to be available any time they press a landing button. They may tolerate a building temperature below normal on a cold morning, but a few minutes' delay in elevator service will be cause for complaint.

The human element looms large as a factor in elevator service. Elevator employees come into contact with the public constantly, and it is necessary that they be selected for their ability to render courteous treatment. It would be an ideal condition if full automatic operation were possible and the human element removed from elevator service entirely. This probably will never be attained in large buildings with heavy passenger traffic. So the next best thing is to use the personnel to best advantage. This can be done by making elevator operation as nearly automatic as possible. Operators can then give attention to serving the requests of passengers.

Operators who have to give a large part of their time to operating the elevator and handling hoistway doors are not likely to be in a continuously pleasant state of mind. If the running of an elevator is reduced to pushing a button it will be certain that the operator will not leave passengers waiting on floors or carry them by.

Elevator equipment may be adequate, but if the cars do not run on schedule the service is not satisfactory. In maintaining a regular schedule for a group of cars the human element has often failed even when street floor departures are controlled by a starter. Checks on elevator service have shown variations in car departure time, from the ground floor, of two and one-half to one, and at the intermediate floors, four to one, even with a starter at the street terminal. This difficulty has been largely overcome by automatic scheduling systems. The starter, being relieved of this responsibility, may give his attention to directing traffic at the terminal so that it is handled with the least confusion.

Flange Heat Losses Versus Welding

FLANGED JOINTS on steam lines are often left bare. This practice is not confined to small and poorly managed plants. Designers of some of the most modern plants, where no expense has been spared, have omitted flange covering as a matter of deliberate choice. While this practice is questionable, the very high cost of covering flanges and the probability of complete destruction of the covering when it is removed to tighten nuts are factors not to be overlooked.

If one decides that the arguments for and against flange covering are evenly balanced in the average plant, this conclusion develops into an important argument for welding. The point that welding saves the cost of the heat that would be wasted from many bare flanges (or, if one prefers, the cost of covering the flanges) is not new, but it needs new emphasis. If the average welding engineer were familiar with heat-loss calculations, he could credit the cost of the all-welded piping system with a substantial saving from this source.

Operating continuously at moderately high steam temperatures, a six-inch flange may easily waste two tons of coal per year. One ton per flange per year would be conservative for typical industrial plant conditions. This loss properly carries not only the bare cost of the coal, but also its share of the cost of firing and ash handling and boiler room fixed charges. With $5 coal, $7 loss per year per flange would be a conservative average. Capitalized at 20 per cent, this is equivalent to an investment of $35 per flange in addition to the erected cost of the joint.

To make the comparison fair one should subtract from this the erected cost of the small additional length of pipe covering required when the flange is omitted, and also the capitalized value of the heat loss through this section. These two items will, however, reduce the $35 by an insignificant amount.

This saving might easily be a deciding factor in specifying an all-welded job. Neither the proponents of welding nor the users of steam piping can afford to overlook an investment item that runs into hundreds and often thousands of dollars.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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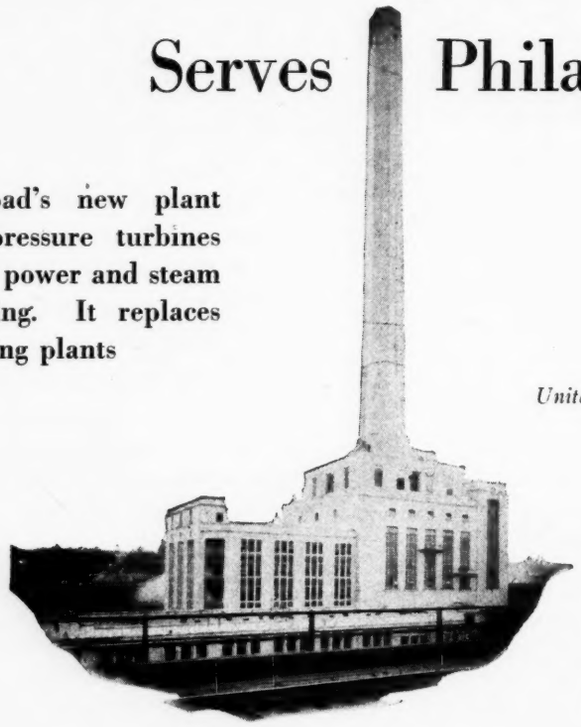
New Central Heating Plant Serves Philadelphia Terminal

Pennsylvania Railroad's new plant contains two back-pressure turbines that supply auxiliary power and steam for feed-water heating. It replaces five old heating plants

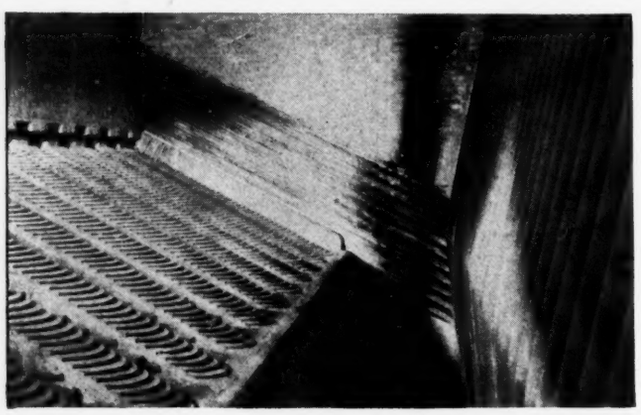
By C. F. DIXON
Supervising Engineer
United Engineers & Constructors, Inc.



IMPROVEMENTS now being carried out by the Pennsylvania Railroad Company in Philadelphia comprise a complete revision of the passenger station, trackage and shop facilities in the West Philadelphia and Broad Street districts.

Steam, water and compressed air for those districts have in the past been supplied from five steam generating and three pumping and compressor plants. Centralization of these services was regarded as a desirable part of the improvement program. For this purpose a plant was constructed, which will contain all equipment to provide these services. The building will also contain facilities for transforming and distributing electrical energy for the signal system, car storage-battery charging, lighting, and miscellaneous power requirements.

The boilers were placed in operation in November, 1929, and the air compressor plant during December of the same year. The electric power facilities will be completed as required by the development of the improvements. Architectural treatment of the building was given careful consideration, the exterior being designed to harmonize with the railroad company's office building at 32d and Market Streets. Exterior walls are faced with light buff brick and limestone trim. The stack, which is superimposed on the building steel, is of reinforced concrete faced with light buff brick. It has a circular cross-section inside, and is octagonal on the outside.



Rear walls of furnaces are water cooled, front and side walls are air cooled

The boiler house is constructed for four 26,230-sq.ft., inclined straight-tube, cross-drum boilers, two of which have been installed and placed in operation. Plans contemplate extension to an ultimate capacity of sixteen boilers. Present boilers are designed for operation up to 275-lb. pressure. No superheaters are installed, but the equipment is designed and arranged in such a manner that they may be added later if necessary. Pressure was selected to meet the requirements of the distribution system, which calls for delivery of steam at 150-lb. pressure to steam apparatus, some of which is 7,000 ft. from the boiler plant.

Boilers are equipped with underfeed stokers, 15 retorts, 45 tuyeres long, dumping into a clinker pit at the end fitted with power-driven clinker grinders. Stokers and grinders are motor-driven through an electro-hydraulic system arranged for variable speed control. Each stoker is supplied with air for combustion by a motor-driven, forced-draft fan having a capacity of 84,000 c.f.m. at 7 in. static pressure. Side and front walls of the furnaces are air-cooled, and the rear entirely water-cooled. Side walls are also water-cooled to a point seven feet above the tuyere line. Ashes are conveyed from the ash pits to a concrete tank by a hydro-jet system, from where they are removed by a traveling crane and grab-bucket to railroad cars.

Space is not available within the improved district for storage of large quantities of fuel, and it was therefore necessary to provide sufficient storage at the plant to take care of emergency requirements. Provision has been made for future construction of a coal pocket alongside the boiler house and under the tracks that serve the coal hopper. This pocket, together with the receiving hopper, will have a capacity of 1,700 tons for

each four-boiler unit. In addition, there is a central bunker over the firing aisle in the building with a capacity of 1,000 tons for each four-boiler unit.

Coal from the track hopper is elevated by skip hoist to the top of the building, passed through a crusher, and delivered by belt conveyors to the coal bunker over the firing aisle. Fuel is delivered to individual boiler hoppers by a weigh larry. Skip, crusher, and belt conveyors were installed in duplicate, each system having a capacity of 100 tons per hour. This equipment is intended to serve eight boilers. The chimney is 21 ft. inside diameter and has a total height of 403 ft. above the grates, or about 425 ft. above the ground level. Cinder catchers were installed between the boiler uptakes and the stack, and space has been provided for future installation of induced-draft fans.

Furnaces, and firing and draft equipment are designed for a maximum hourly evaporation of 276,000 lb. of water from each boiler.

About 40 per cent of the steam is returned as condensate from heating coils, etc. City water, treated in a hot-process lime-soda system is used for the remaining 60 per cent. Feed water is heated by exhaust steam from two 1,750-kw. non-condensing turbine-generators. Two deäerating, open-type heaters are installed, one of which receives the condensate returns and delivers them direct to the boiler-feed pump; the other is fed with city water, which, after deäeration and heating, is delivered to a hot-process storage and reaction tank. From the reaction tank it flows as required to the boiler feed pump.

All station auxiliaries are motor-driven with the exception of one turbine-driven boiler feed pump for emergency use. The main source of power for auxiliaries and general service is the local public utility. Only as much energy is generated as will provide the proper amount of exhaust steam to maintain a feed-water temperature of 212 deg. F. The capacity of the two 1,750-kw. turbine-generators is sufficient to carry the house auxiliaries, emergency lighting, power for air compressors and signal system, and may be used for this service in case of failure of external power. These units may also be used for power factor correction.

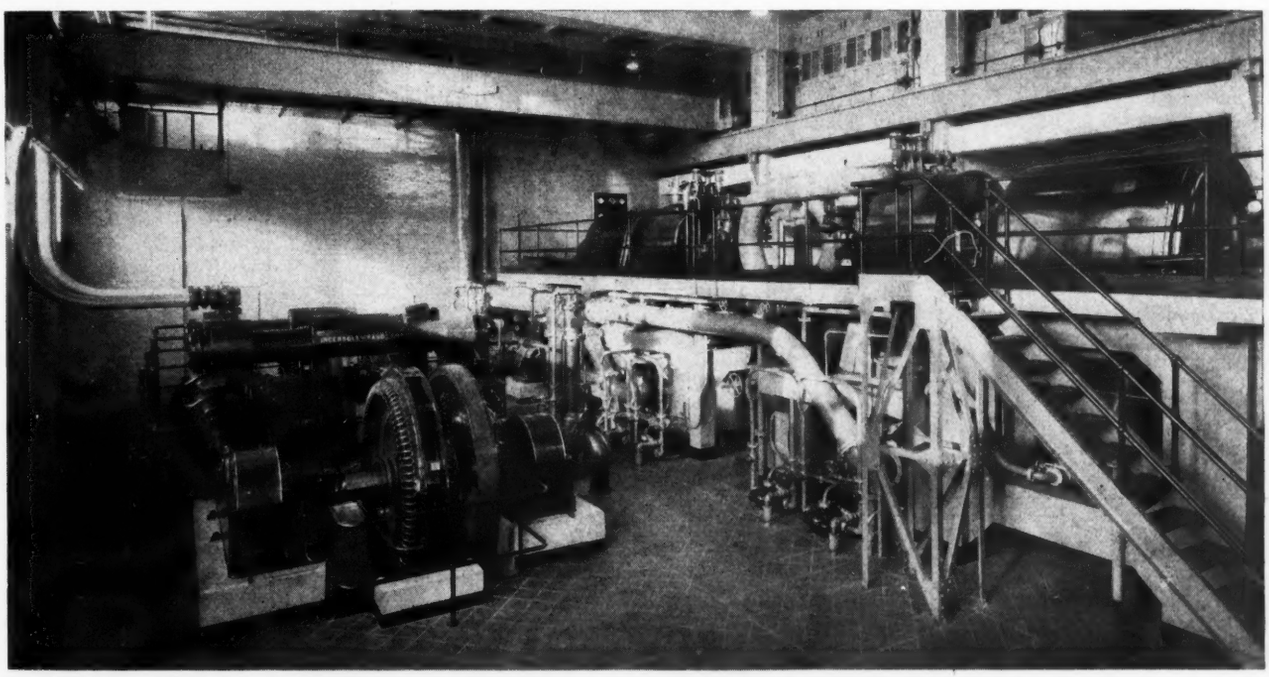
Each boiler is equipped with combination boiler-feed and excess-pressure regulators, and the motor-driven feed pumps are run at constant speed. The forced-draft fans are driven by alternating-current, slip-ring motors with variable speed control. The boiler plant is equipped with automatic combustion control designed to regulate stoker and fan speed and uptake dampers on the boilers in accordance with load demands.

Combustion control instruments and recording pressure gages are mounted on a master gage board at the end of the firing aisle. An individual board on which steam gages, draft gages and boiler meters are mounted is located at each boiler. Each boiler is also provided with a recording Venturi meter, which measures flow of feed water to the boiler. These instruments, together with the coal weigh larry, give a complete record of plant operation.

A concrete storage tank of 180,000-gal. capacity provides a reserve supply of treated water for the plant and also serves as a surge tank for the system. It receives overflow from the condensate heater when returns are in excess of immediate feed demand, and supplies the make-up pump when the returns or the treating system are inadequate.

Demand for practically all steam generated is at points remote from the plant. It was necessary, therefore, to provide an adequate steam distribution system. The building's being within the railroad yards made it necessary to carry principal pipe lines underground. A main tunnel was constructed from the plant to the Broad Street station, a distance of approximately 7,000 ft. This tunnel is of sufficient size to take care of the present and future steam mains and the air and other service piping necessary for the railroad system. Two 18-in. high-pressure 250-lb. steam mains were installed throughout the length of this tunnel. Branch lines run to the various buildings, where reducing valve stations

Steam from back-pressure turbines is used for heating feed water

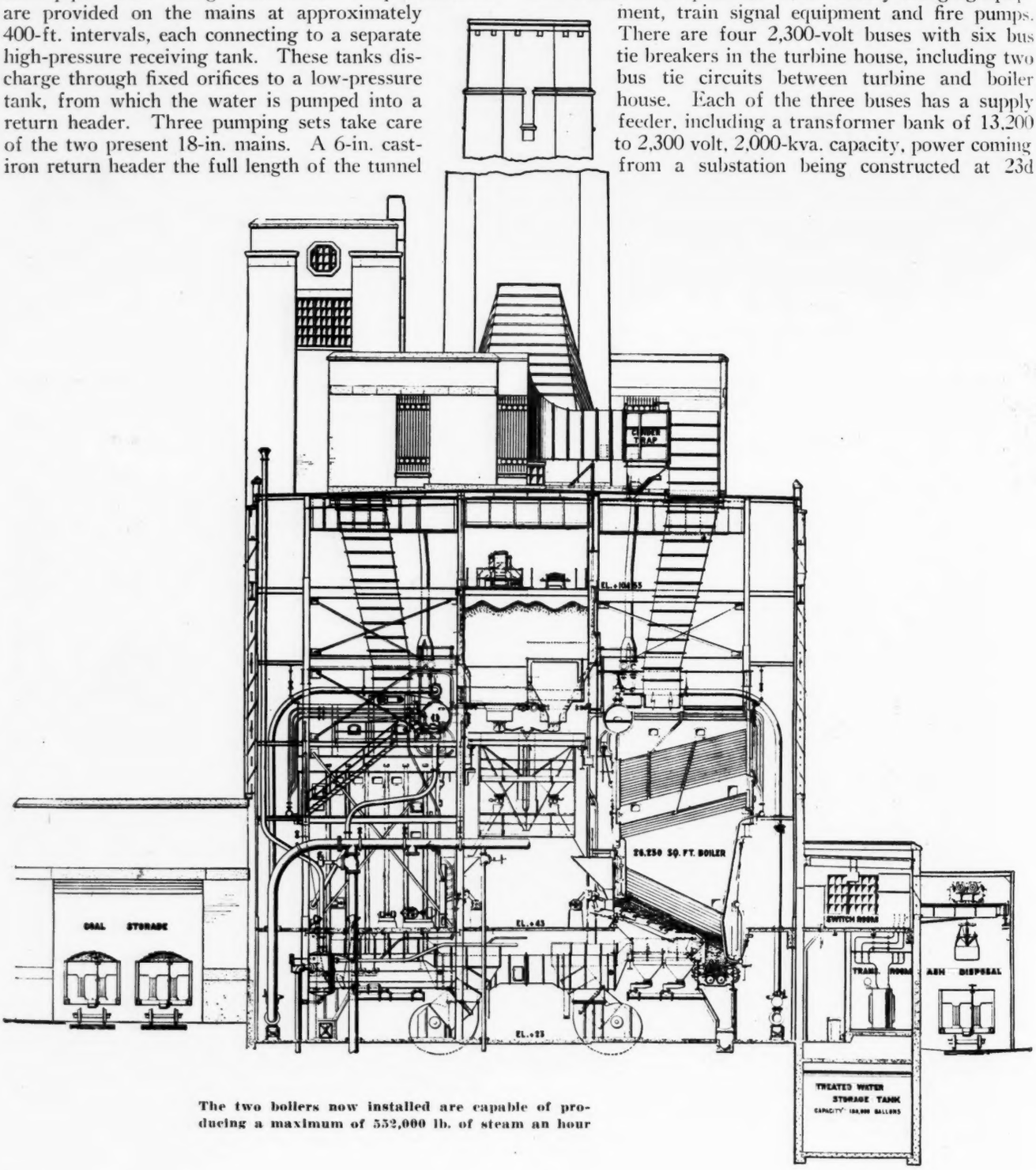


lower the pressure for heating or use in other equipment.

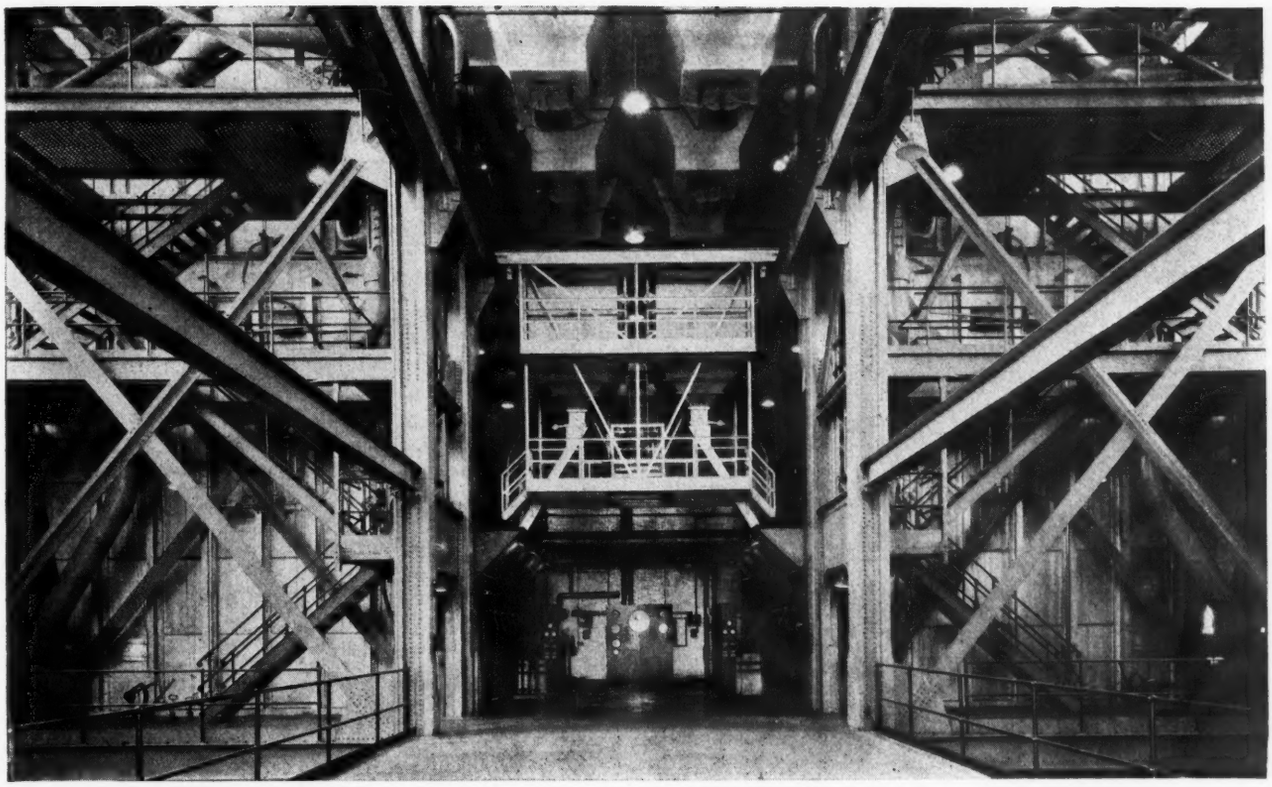
Expansion in the headers and mains leaving the boiler plant is taken care of by pipe bends. In the tunnel, expansion is taken care of by guided slip-type expansion joints, the pipe being securely anchored at the center of the run between each pair of joints. Distances between joints vary from 300 to 400 ft. Pipe ends attaching to the slip joints are fitted with Van Stone flanges. All other joints are butt welded, reinforced with a split sleeve welded to the pipe at the ends, the longitudinal seam of the sleeve remaining open. Each sleeve has a single corrugation rolled midway of its length to provide flexibility and clearance over the butt weld. Branch outlets have flanged nozzles welded to the main pipe. Few fittings were used. Drip connections are provided on the mains at approximately 400-ft. intervals, each connecting to a separate high-pressure receiving tank. These tanks discharge through fixed orifices to a low-pressure tank, from which the water is pumped into a return header. Three pumping sets take care of the two present 18-in. mains. A 6-in. cast-iron return header the full length of the tunnel system discharges directly to the condensate heater in the boiler house. This header also receives any condensate that may be reclaimed from the heating systems and other equipment.

Two 1,750-kw. non-condensing turbine-generators, three 2,500-c.f.m. motor-driven air compressors, of which two have been installed, two 1,000-g.p.m. motor-driven fire pumps, together with motor-generator sets, transformers and switching equipment, are installed in the turbine house.

The turbine house substation supplies 2,300-volt, 3-phase, 60-cycle power for air compressors, yard lighting, power and light for repair shops, roundhouse, etc., emergency lighting for the new Broad Street station and new West Philadelphia station, car battery-charging equipment, train signal equipment and fire pumps. There are four 2,300-volt buses with six bus tie breakers in the turbine house, including two bus tie circuits between turbine and boiler house. Each of the three buses has a supply feeder, including a transformer bank of 13,200 to 2,300 volt, 2,000-kva. capacity, power coming from a substation being constructed at 23d



The two boilers now installed are capable of producing a maximum of 552,000 lb. of steam an hour



Initial boiler installations at the Philadelphia central heating plant of the Pennsylvania Railroad

Street. The nature of services supplied from the turbine house substation is such that reliability is of utmost importance. For this reason there are seven independent sources of power supply. These consist of five 13,200-volt feeders from the Philadelphia Electric Company system, and two feeders from the 1,750-kva. generators in the turbine house. Each generator is connected through breakers to three of the 2,300-volt turbine house buses. Two feeders from the Philadelphia Electric Company system go direct to the boiler house buses and thence through tie circuits to the turbine house bus system; the other three feeders go through the substation at 23d Street. The five Philadelphia Electric Company feeders cannot be paralleled with each other, but any one can be paralleled with one of the 1,750-kva. generators. Switching arrangement is such that any one of the 2,300-volt buses may be supplied from any one of the seven sources of power.

The bus which supplies the most important circuits, such as emergency lighting of passenger stations, train signals, fire pumps, etc., will normally be supplied by one of the three feeders to the turbine house. One of the 1,750-kva. generators will be connected to and float on this bus ready to pick up the load if the feeder fails. In case of failure of the feeder, the operators will immediately connect one other incoming feeder to this bus so as always to have two sources of supply connected.

The electric substation is on the first and second floors of the turbine house. On the first floor are three 100-kw., 80-volt direct-current motor-generator sets for car battery charging; two 75-kva., 440-volt, 100-cycle motor-generator sets for train signals; and one 12-kw., 125-volt, direct-current, motor-generator set for emergency excitation to the 1,750-kva. generators. Also on this floor are switchboards totaling 90 ft. in length, and consisting of control and relay, exciter, car battery-charging and supervisory control switchboards. The supervisory control is for control of 23d Street substation of the railroad.

On the second floor, or balcony, are 35 2,300-volt truck-type switchboards; eight circuits of 6,600-volt, 100-cycle for train signal supply, housed in a compact fireproof structure; and the 230-115-volt station service switchboard, station control battery and charging equipment.

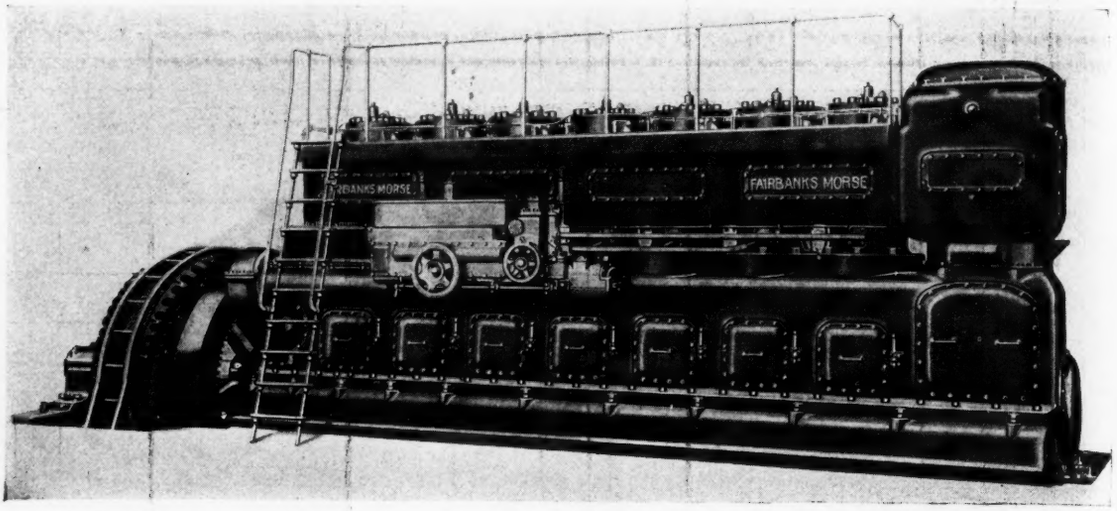
The double independent feeder scheme is carried through to the 230-volt buses by way of two 2,300- to 230-volt transformer banks. The two 230-volt buses have a tie breaker.

Separate transformer vaults and switch house will be provided for each unit of four boilers. Units will be so arranged that power from the Philadelphia Electric Company system may be delivered direct to the boiler plant. If either feeder to the 2,300-volt buses fails, the bus tie breaker closes automatically after the faulty circuit is cleared. This is done without dropping load, because timing of relays on the feeders is short enough to allow transfer of the source of power before the time-delay undervoltage protection on each motor can operate. The same automatic throw-over plan is applied to the 230-volt buses.

The boiler house operating engineer has a drop signal panel in the firing aisle which shows the position of every oil circuit breaker, carbon breaker and contactor in the boiler house, except for the few contactors that are automatically operated by float switches.

Fan, boiler-feed and ash-sluice motors are 2,300-volt, and all other motors are 230-volt, except valve control motors, which are 125-volt direct-current.

The steam heating plant was designed and constructed by United Engineers & Constructors, Inc., under supervision of Robert Farnham, chief engineer of Philadelphia improvements, and T. P. Watson, principal assistant engineer of Philadelphia improvements, of the Pennsylvania Railroad.



A New DIRECT-INJECTION TWO-CYCLE DIESEL

SEVERAL distinctive improvements have been made by Fairbanks, Morse & Company in their two-stroke-cycle mechanical-injection Diesel. These include the injection of the fuel directly into the engine cylinder (in place of the precombustion chamber arrangement heretofore used), the employment of a multiple-orifice spray nozzle, and a separate scavenging pump in place of crankcase scavenging.

From Fig. 2 it will be noted that the new cylinder head is a simple symmetrical casting and that the inner wall conforms to a sphere. This permits a minimum thickness of metal, with a consequent ready flow of heat to the cooling water. Vertical stiffeners within the water jacket space add to the strength, and a baffle, to direct the flow of cooling water most effectively, is cast in place. To obtain the desired clearance volume the crown of the piston is made slightly concave. The injection nozzle is mounted in the center of the cylinder head and secured by two bolts.

To prevent high temperatures on the piston crown, oil cooling of the piston has been adopted. A part of the lubricating oil supply passes up through the drilled connecting rod into the cavity formed by the inner and outer walls of the piston crown, these two walls being separate castings. Oil leaving the cavity flows down through a tube into a receptacle above the main bearing, out of which it drips into the crankcase oil pan.

The new-design nozzle jets its oil into the cylinder. As will be noted from Fig. 1, it contains a spring-loaded needle valve which has a lapped fit in a bushing, or guide. Fuel is forced by the injection pump into the space between the guide and nozzle body, and when the pressure builds up sufficiently it lifts the needle valve against the spring tension, the shoulder on the lower end of the valve acting as a piston. When the valve is lifted from its seat the fuel is injected in the form of a fine spray through several holes in the tip. All parts of the nozzle that come in contact with the fuel are of non-corrosive material, and where necessary they are hardened and ground to a proper fit within close limits.

The only adjustments are for lift and spring tension. The former is accomplished through the screw at the top, and the latter by shims above the upper spring cap. These are initial adjustments only and need not be changed thereafter. Special non-corrosive and stainless material is used in the small parts that come in contact with the fuel.

One objection to fuel nozzles in the past has been clogging of the tips, and until a comparatively short time ago there was no safeguard against this. On this new engine a metallic strainer will not pass a particle having a diameter over 0.0035 in. This strainer has been adopted as standard equipment on all engines with "open" heads, and since the openings in

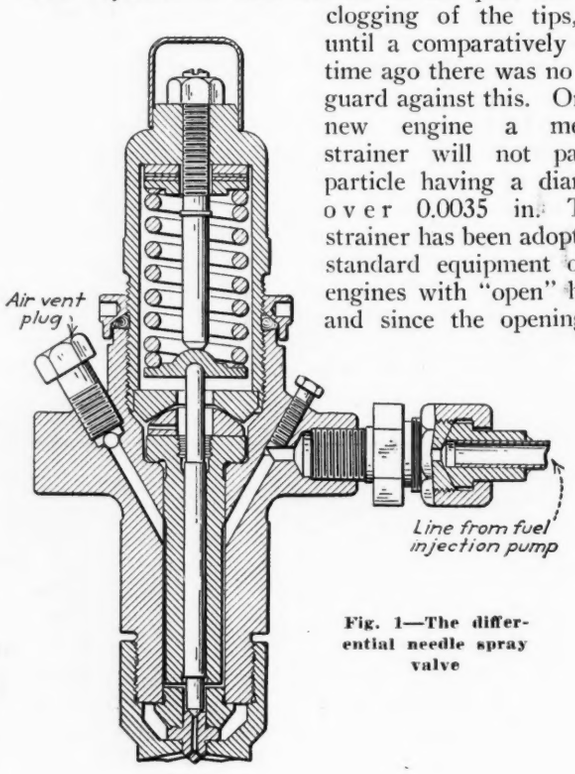


Fig. 1—The differential needle spray valve

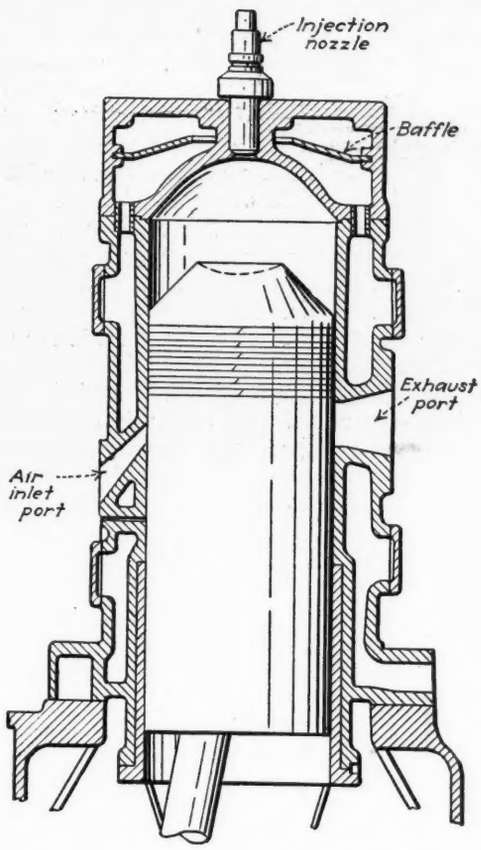


Fig. 2—The oil is injected into the working cylinder

the spray tip are much larger than those in the strainer, clogging should be prevented. Injection-pump pressure is somewhat higher with this type of nozzle, and so the injection pumps used on the precombustion engines have been made heavier, and a relief valve has been provided on each pump discharge; but there are no other changes in the injection mechanism.

These improvements have resulted in a more intimate mixture of fuel and air, and consequently better combustion and a lower fuel consumption. The new fuel guarantee on engines with 16x20-in. cylinders is 0.41 lb. per brake horsepower-hour at full load; 0.43 lb. at three-quarter, and 0.46 lb. at one-half load. The lubricating oil guarantee is 3,500 rated horsepower-hours per gallon.

Aside from the advantage of lower fuel consumption, the improved combustion resulting from these developments results in other distinct advantages from the standpoints of operation and maintenance.

Starting is easier and low-speed operation is improved as a result of these developments, because with an open-type head the desired turbulence of fuel and air is more or less independent of the speed. As a matter of fact, the compression pressure has been materially reduced with the adoption of the open head because of this condition, and 450 lb. is ample, whereas the precombustion design required around 550 pounds.

Due to more rapid combustion, as a result of a more intimate mixing of air and fuel, burning should be completed earlier in the stroke, with a consequent longer period for expansion, a greater cooling of the gases, lower exhaust temperature, and lower mean temperature for the cycle. These more favorable heat conditions account for the favorable lubricating conditions obtained, and should result in less scale formation, which, in turn, means greater dependability and less maintenance.

Coal-Pulverizing Cost Reduced by Centrifugal Lubricator

AT THE Gould St. Station of the Consolidated Gas, Electric Light & Power Company, of Baltimore, pulverized coal is used to fire two 30,156-sq.ft. cross-drum boilers which supply steam to two 36,000-kw. turbines. Coal is pulverized in two 20-ton six-roll Raymond mills.

The rolls of these mills as originally installed were designed for lubrication with grease, which was stored in reservoirs *A* Fig. 1. Grease cost 5c. a pound, and an average of 0.3 to 0.4 lb. was used per ton of coal milled. On a test run of 85,000 tons of coal, grease cost $1,530. It was necessary to shut down the mill every six hours, sometimes oftener, to permit greasing.

Frequent mill shutdowns for greasing occasioned considerable inconvenience, and the cost of lubrication seemed excessive. Accordingly, an investigation was started which led to development of a lubricating device that uses a high-grade lubricating oil developed by the Texas Company, which also co-eporated in the design of the new lubricator. This oil costs 30c. per gallon, and operation with the new device indicates an oil consumption of 0.052 pints per ton of coal milled. Each oil reservoir holds slightly less than 2 gal., but in operation the reservoirs are never allowed to become more than half empty, which procedure permits about 40 hr. of operation between mill shutdowns. As an operating routine the reservoirs are filled after each 30 hr. of operation. On the basis of 85,000 tons of coal milled, cost of lubrication was reduced to $168, compared to $1,530 for grease.

In the main, this device consists of a bronze casting which replaces the flanged cover on the upper end of the roll housing. The bulk of this casting extends down into the space previously provided for grease. The reservoir is provided with an opening closed by a cap *A*, Fig. 2, which permits of introducing oil into the reservoir. In the side of this opening is a boss through which a hole is drilled to permit of venting the oil reservoir to the roll housing, so that the air pressure is the same in the reservoir and in the housing. An eccentric lug on

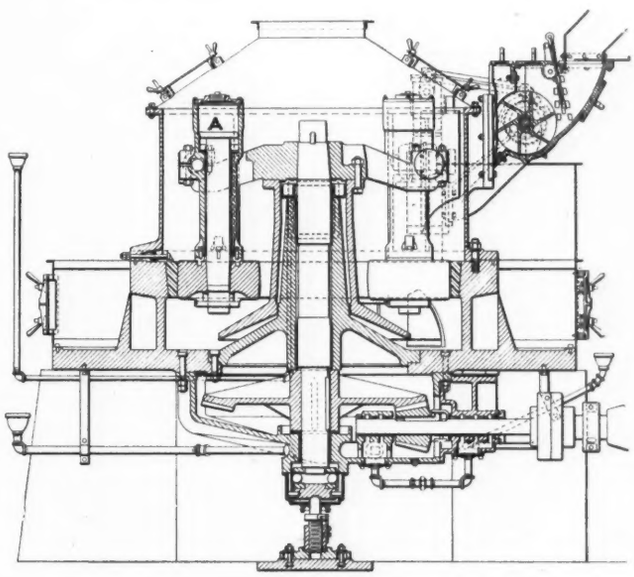


Fig. 1—Cross-section of pulverized coal mill showing location of lubricator

the cap provides an unbalanced centrifugal force which tends to keep the cap from working loose.

A plugged opening in the bottom of the oil reservoir gives an opening for supporting the core when making the casting, and as an additional means of cleaning any heavy residue out of the reservoir.

Diametrically opposite the fill opening there is a compartment that is an integral part of the reservoir, being connected to it by five $\frac{1}{4}$-in. drilled holes, as shown in Fig. 2. An opening through a boss directly under this compartment extends down to the bottom of the reservoir casting. As this opening is difficult to core and expensive to drill, a $\frac{1}{2}$-in. o.d. steel tube was set up in the mold to act as a core. The steel tube, left in place in the finished casting, provides a uniform opening. The upper end of this opening is fitted with a brass nipple into which is beaded and sweated a $\frac{3}{64}$-in. i.d. copper tube fitted with two brass collars that limit any tendency for it to vibrate.

After the nipple and its tube are screwed into the tapped opening, care being taken to see that the joint is oil-tight, the small compartment is filled with wool felt or plaited wool rope and is closed with a cap *C*, Fig. 2, which must be applied so as to form an oil-tight joint.

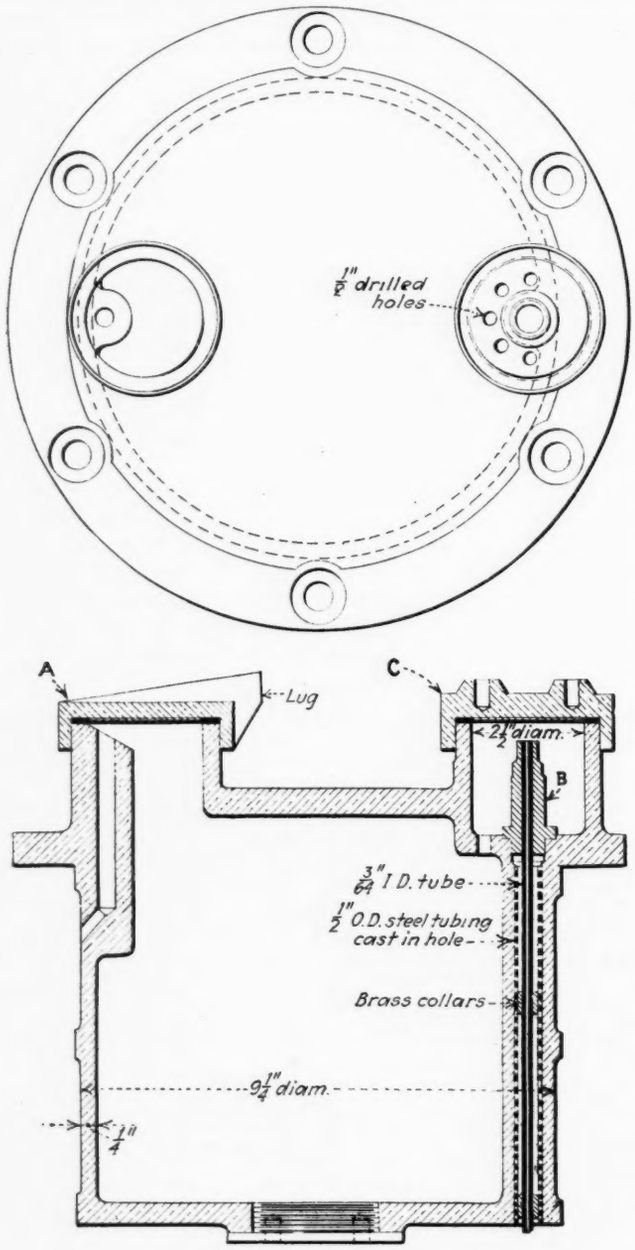


Fig. 2—Plan and sectional elevation of centrifugal lubricator

The reservoir casting is installed in place of the flanged cover at the top of the roll shaft housing, care being taken to see that the small compartment which contains the nipple is the maximum distance away from the center of the mill's vertical drive shaft. This is necessary, as the centrifugal force set up when the mill operates is depended upon to empty the reservoir, the oil passing up through the felt filter and down through the copper tube. Size and length of the copper tube control the rate at which oil drops from its lower end on to the top of the roll shaft.

It is essential that all of the threaded connections be oil-tight. It was found that this could be accomplished only by using straight threads and gaskets. It is also necessary that the thickness of the gasket under the cap *A*, Fig. 2, be such that the eccentric lug on this cap casting points away from the main shaft of the mill, so that the centrifugal force tends to keep the cap screwed up tight.

Use of copper tubes was developed from known laws of tubes as used in Barbey viscosimeters, flow for any head depending upon length and diameter of tubes and viscosity of the oil. Consequently, viscosity of the oil should be varied with the temperature at which the mill operates. It must also be fairly high-grade, straight-run lubricating oil.

In this case preheated air is used in the mills for drying, so it is necessary to use a fairly heavy oil (750 to 780 Saybolt at 100 deg. F.). Where the mill temperature is lower, a lighter oil would be needed, or the length of the tube should be somewhat shorter.

In addition to the reduction in cost of lubricant, considerable saving in labor has resulted from less frequent shutdowns, with consequently increased available capacity per unit of time for the mills. Trouble with sticking rolls has been eliminated, and the roll shaft and bearing sleeves do not wear nearly so rapidly as they did when grease was used. There is, therefore, quite an appreciable reduction in mill maintenance, which saving apparently is much greater than the decrease in cost of lubricant. The mills do not have to be taken out of service for other than replacing of rolls and bull rings, which again increases actual annual mill capacity.

About ten months have elapsed since completion of experimental work and installation of the lubricators in their present form, during which time they have given no trouble.

Investigations indicate that the rate of feeding oil is greatly in excess of that needed. However, the saving to be gained by adjusting this is relatively small and can be accomplished only by using a very heavy oil, which might not feed until the mill becomes thoroughly heated, or by installing a smaller diameter tube, which might get clogged by small particles of foreign matter in the oil. These conditions offset any slight saving that might be realized by decreasing the amount of oil required.

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TESTING STEEL SHEET FOR WELDABILITY—For successful oxy-acetylene welding of steel careful selection of material is necessary. Welding qualities are determined largely by presence or absence of minute amounts of impurities. These are so small that it requires a good microscope to detect them. They do not show up in a chemical analysis. It is advisable to specify that steel be suitable for welding, and to test the steel as received.

AIR CHART

Simplifies COMPRESSION CALCULATIONS

By THOMAS M. GUNN
Brooklyn, N. Y.

IN CONNECTION with the compression of air, its storage and use, there are many problems which are simple enough to those who are constantly dealing with such matters, but are rather annoying to the engineer who must solve them after the subject has become stale in his mind. One reason is that the formulas found in textbooks are in terms of units that are not in daily use. Absolute pressures in pounds per square foot, absolute temperatures, and exponential equations easily lead to confusion.

Air has weight. Air at 67 deg. F. occupies about 13¼ cu.ft. per pound at sea level. This is under normal atmospheric pressure of 14.7 lb. per square inch. As this pressure is due to the weight of the upper layers of the atmosphere pressing on the lower layers, we may say that a column of air one square inch in cross-section and extending to the upper limits of the earth's atmosphere weighs 14.7 pounds.

It follows, reasonably, that if we climb to elevations higher than sea level, atmospheric pressure will become less. The decrease is at the rate of about ½ lb. per square inch for every 1,000-ft. rise. As this rate does not remain the same at high elevations, a scale is given in Fig. 1 to show atmospheric pressure at any elevation from 5,000 ft. below sea level to 25,000 ft. above.

Pressure gages show the difference between the pressure within the instrument and the surrounding atmosphere; so a gage pressure of 20 lb. at sea level is 34.7 lb. abs., while 20 lb. gage pressure at 5,000 ft. altitude is only 32.3 pounds absolute.

Air undergoes changes with altered pressure and temperature. The volume of one pound of air decreases in the inverse ratio to its absolute pressure, and increases directly as its absolute temperature.

The general relation between pressure, volume per pound and temperature is:

$$\textit{Pressure, lb. per sq.in. abs.} \times \textit{Volume cu.ft. per lb.} = .37 \times (\textit{Temperature, deg. F.} + 460)$$

If two of these factors are known, we may calculate the third.

Referring to the chart, Fig. 2, it will be found easy to solve this formula without calculation. For instance, if we wish to know the volume per pound of air at 14.7 lb. abs. pressure, which is the pressure of free air at sea level, and at a temperature of 75 deg. F., it is only necessary to lay a ruler across the chart from the proper point on the pressure scale to that on the temperature scale and read the volume on the volume scale, 13½ cu.ft. per pound.

The pressure scale on this chart shows gage pressures at sea level as well as absolute pressures. Of course the gage readings will not be just right at high elevations, but are given for convenience in cases where correction for altitude is unnecessary.

As another example, suppose that a tank is filled with air at 100 lb. gage pressure and a temperature of 150 deg. F. and stands without leakage until it has cooled to 30 deg. F. on a winter day. There will be a drop in pressure due to shrinkage. This is found by first drawing a line from 100 lb. gage on the pressure scale to 150 deg. on the temperature scale, and then, since volume does not change, drawing a second line intersecting the volume scale at the same point as the last line and extending from the 30 deg. point on the temperature scale, to the pressure scale. Here the reading is 78 lb. gage. Hence the loss of pressure due to cooling has been 22 pounds.

If we assume that the tank has a volume of 200 cu.ft., it is also easy to find the weight of air in it. The intersection on the volume scale shows a volume of 1.95 cu.ft. per lb. Divide 200 by 1.95 and the result is 102½ lb. weight of air in the tank.

This chart has another use, to calculate the change of temperature of air during compression in a cylinder. A compressor takes in air and, in a single stroke of the piston, raises the pressure to a certain desired amount. This is done so quickly that there can be little transfer of heat to or from the cylinder walls. Theory shows that air compressed without transfer of heat, that is, adiabatic compression, will follow a certain mathematical law such as expressed by the following formulas:

$$\textit{Absolute Pressure} \times \textit{Volume}^{1.41} = \textit{Constant}$$

$$\left[\frac{\textit{Final pressure}}{\textit{Initial pressure}}\right]^{0.29} = \left[\frac{\textit{Final absolute temperature}}{\textit{Initial absolute temperature}}\right]$$

Here are some exponential equations that require some skillful use of the slide rule, if not of logarithmic tables. This is, however, avoided by the use of the diagram, with the addition of the vertical line marked "entropy."

For example, if air is compressed from zero gage to 85 lb. gage, starting at a temperature of 75 deg. F. before compression draw the line from zero gage on the pressure scale to 75 deg. on the temperature scale, and note its intersection on the entropy line. Second, draw a line from 85 lb. on the pressure scale through the intersection on the entropy line and extending to the temperature scale. Here the temperature after compression may be read 472 deg. F.

This compression represents a rise of temperature of 472 — 75 = 397 deg. F.

The volume per pound has been decreased by this compression from 13½ cu.ft. to 3½ cu.ft. per pound. This is found by reading the intersections on the volume scale.

The work done in the compressor can be reduced to horsepower of the air cylinder. Just to show what may be avoided by the use of such a chart as this, the complete formula is set down.

$$W = P_1 V_1 \frac{n}{n-1}\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1$$

This gives the work of compression, in foot-pounds, in terms of initial absolute pressure, of pounds per square foot; of initial volume, cubic feet; of ratio of compression; and of the number n, of which has a value of 1.41 for adiabatic compression of air.

There is a short cut which depends upon the rise in temperature that is just as accurate. The work done in compression is converted into heat, and this heat is shown by the rise in temperature. Set in the form of an equation it is:

Work done, ft.-lb. per pound of air
$= 778 \times 0.2375 \times$ *(temperature rise)*

In this, 778 is the number of foot-pounds of mechanical work equivalent to 1 B.t.u. of heat, and 0.2375 is the specific heat of air at constant pressure.

To reduce to horsepower, it is convenient to calculate in terms of a standard capacity of 100 cu.ft. per minute. It is then easy to convert the power to that of a compressor of known dimensions.

For a capacity of 100 cu.ft. of free air per minute, the horsepower is:

$$100 \times \frac{778 \times 0.2375}{33{,}000} \times \frac{\textit{Temperature rise}}{\textit{Initial vol. per lb.}}$$

By reducing these constants to a single number, this formula becomes as follows:

$$\textit{Hp. per 100 cu.ft. per min.} = 0.56 \times \frac{\textit{Temperature rise}}{\textit{Initial vol. per lb.}}$$

Both temperature rise and the initial volume per pound may be found by the chart. In the problem worked out above, the temperature rise was 397 deg. and the intial volume per pound was 13½ cu.ft. So the horsepower is $0.56 \times \frac{397}{13.5} = 16.5$ *hp. per 100 cu.ft. per min.*

Evidently, pressures and volumes can easily be found

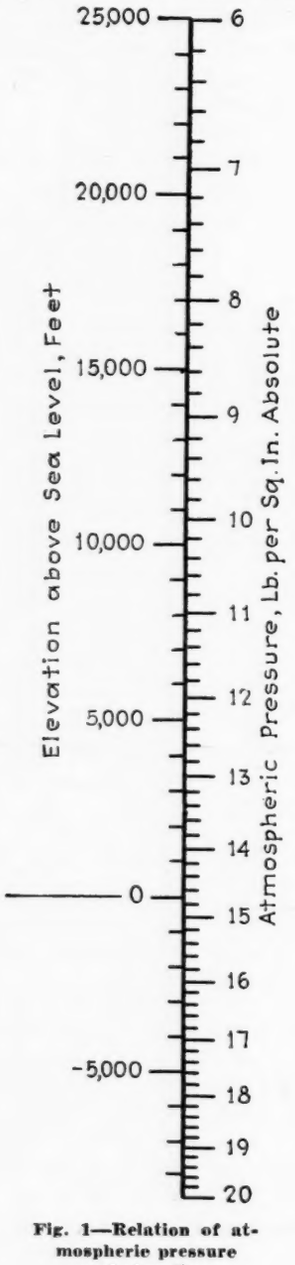


Fig. 1—Relation of atmospheric pressure and elevation

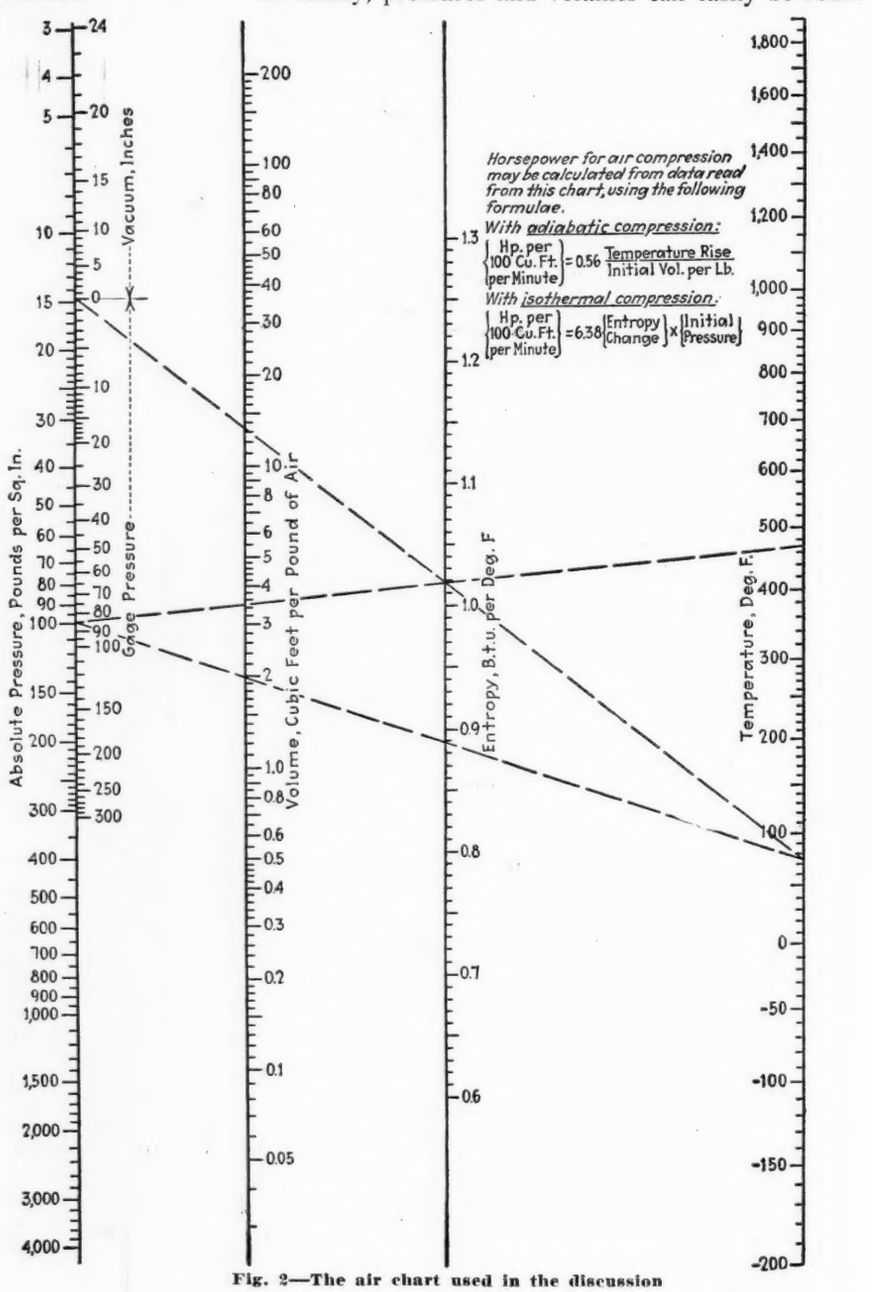

Vacuum, Inches
Absolute Pressure, Pounds per Sq. In.
Gage Pressure
Volume, Cubic Feet per Pound of Air
Entropy, B.t.u. per Deg. F
Temperature, Deg. F.
Horsepower for air compression may be calculated from data read from this chart, using the following formulae.
With adiabatic compression:
(Hp. per 100 Cu. Ft. per Minute) = 0.56 Temperature Rise / Initial Vol. per Lb.
With isothermal compression:
(Hp. per 100 Cu. Ft. per Minute) = 6.38 (Entropy Change) × (Initial Pressure)

Fig. 2—The air chart used in the discussion

for an "isothermal compression" by pivoting the ruler at a fixed point on the temperature scale. Two broken line are shown on the diagram to illustrate isothermal compression from normal atmosphere to 85 pounds gage, at a constant temperature of 75 deg. F.

To find the amount of work done in isothermal compression, a scale is constructed on the entropy line. There is no need here to explain what entropy is, but we can use it with the greatest ease. Read the intersections of the two broken lines with the entropy scale and subtract.

1.019 — 0.888 = 0.131 = *entropy change*. Having found this number, the horsepower for a capacity of 100 cu.ft. of free air per minute is as follows:

$$\frac{100 \times 778}{.37 \times 33{,}000}(E_1 - E_2) \times p_1$$

This may be simplified and expressed in words as follows:

Hp. per 100 *cu.ft. per minute*
= 6.38 × *Entropy change*
× *Initial pressure lb. per sq.in. abs.*

For the example, this is 6.38 × 0.131 × 14.7 = 12.29 hp. per 100 cu.ft. per min., the same result as would be secured by the usual formula, involving the logarithm to the base *e* of the ratio of pressures.

In addition to the numerous specific problems that may easily be solved by these short cuts, there are some important generalities that may be seen by a little study of the data that have been given.

Soap Solution Cleans Powdered Coal Vents

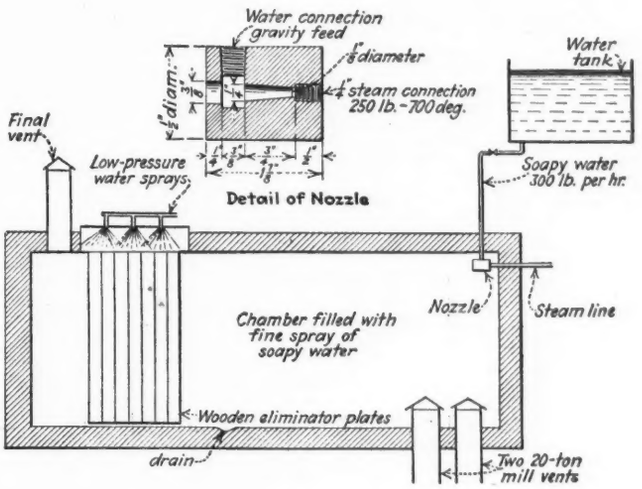
ABOUT a year ago Lakeside plant of the Milwaukee Electric Railway and Light Company joined in the general movement started at that time in pulverized-coal plants toward reducing the amount of vented coal in an attempt to eliminate the dust nuisance both within and outside the preparation plant. By equipping two 20-ton mills with auxiliary cyclones and providing special vents on eight 6-ton mills, the amount of vented coal was reduced 15 per cent.

In the auxiliary cyclone installation the vent is removed at the fan discharge, the fans themselves being on the clean side of the main collectors. Pressure in the discharge line is sufficient to force the vented air through the small auxiliary cyclone and thence to the roof of the pulverizing house, where the dust laden air enters a chamber fitted with wood plate eliminators and low-pressure water sprays and a final vent to atmosphere. As the coal removed in the auxiliary cyclone was returned to the mill and the vented air passed through a water spray, the coal dust sent to atmosphere through the final vent was greatly reduced. In winter the vent appeared as a clean white vapor, and in summer the vented coal was visible as a fine dust.

While the results obtained were encouraging, some coal dust was still being vented to atmosphere. The water apparently did not function as efficiently as anticipated. An investigation was made and some simple experiments with a test tube disclosed a method of correction.

It was found that if powdered coal was dropped into a test tube partly filled with water the coal would float on the surface. If the tube was shaken, the coal would not mix with the water. As little as one-half of 1 per cent soap added to the water readily wetted the coal dust, which dispersed and sank in the water.

It was a simple matter to apply soap to the washing process in the chamber on the roof. A inexpensive method operating at low cost is shown in the accompanying illustration. From the two 20-ton mill vents, 3,000 cut.ft. of air per minute and 45 lb. of coal per hour are delivered into the chamber. To fill the chamber with a fine spray of soapy water, an elevated tank was provided that holds 7,200 lb. of water to which 10 lb. of soap and 5 lb. of tri-sodium phosphate are added. This



Soapy spray dust removal system

supply lasts for 24 hr. Feed is by gravity to a nozzle requiring 100 lb. of steam per hour at 250 lb. pressure and at a temperature of 700 deg. F. to spray the soapy solution into the chamber. The detail of the nozzle shows the design and the dimensions.

Consecutive observations with and without the soap solution demonstrated the value of using some agent that would insure the wetting of each particle of coal, for the vent would change, respectively, from steam white to brown dust. With the soapy water shut off, the steam spray alone would not function efficiently. When using the soap the dust concentration in the vent is so small that it cannot be detected by the usual sampling methods and the vent is steam white at all times.

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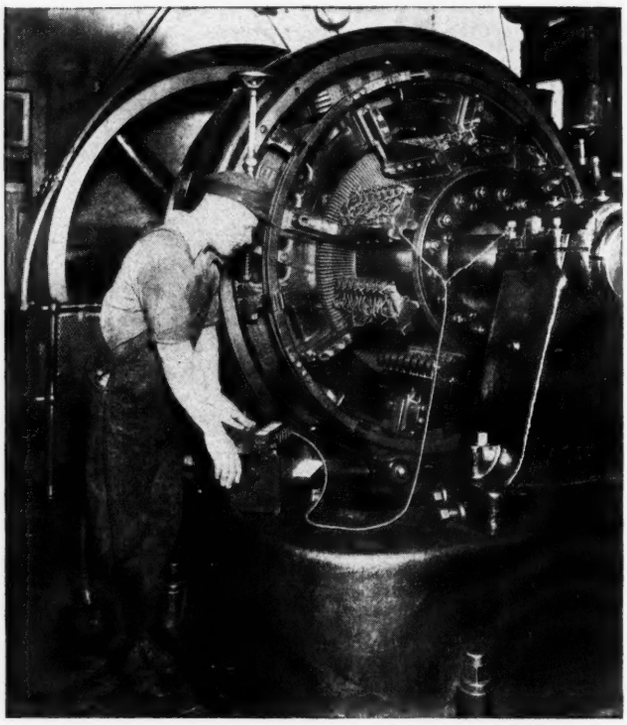
KIDDING WITH EINSTEIN—According to *The Valve World*, Professor Small recently threw the following bomb at a Chicago dinner: "Some of you gentlemen, I believe, are engaged in the heating industry, and I would like to inquire whether, when designing radiators, you have made a proper study of quantum and frequency. No? Well, they are most important. The idea is to multiply frequency by a constant which is of the physical nature of energy multiplied by time, or 655 nonillion ergs plus seconds. The application of this startling conception to cast-iron radiators will revolutionize the industry, and if the opportunity were given, I should like to develop the idea more fully before an intelligent body, such as the Central Supply Association!"

Moisture is the enemy of electrical machinery and must be avoided if reliable operation is to be attained. There are many ways of drying out electrical equipment, which vary with the kind of machinery. A number of methods used successfully by operating engineers are described in this article



Testing insulation resistance with a Megohmer

DRY INSULATION Insures Reliable Operation

By ROBERT BALL
Pittsburg, Calif.

ALTERNATING-CURRENT generators are generally dried out by operation on short-circuit, although hot air is sometimes used to save time in erection or because the prime mover is inoperative. The short-circuit method is simple, requiring no auxiliary equipment except simple short-circuiting conductors. Insulation is not stressed, and during the dry-out run the prime-mover equipment can be tuned up. It is desirable that switchboard instruments, particularly ammeters, temperature indicators, speed indicators and signal equipment be in use during the dry-out run. All instruments should be tested to insure their accuracy.

Operation at normal speed appears desirable when conditions permit. If operation at low speed is necessary, where possible it is well to use a temporary governor pulley of such diameter as will maintain the desired speed, rather than let an attendant control the speed.

During a generator dry-out run records should be made every half half of the alternating-current amperes, direct-current field amperes, direct-current exciter voltage, all temperatures indicated by exploring coils or found by thermometers on the windings and laminations, the temperature of the incoming air, generator speed, and bearing temperatures.

Current should be regulated with reference to the exploring coil or thermometer giving the highest reading, and in no case should it exceed 125 per cent of full-load rating. Current regulation is obtained by varying the exciter voltage, adjusting the main field rheostat, or by both. The main field rheostat can be dried out by leaving part of it in circuit. In addition to changes in current, the temperature may be regulated by varying the amount of air or water employed for cooling purposes.

Insulation-resistances readings should be taken every 8 hr. until constant or nearly constant values are obtained. Subsequent readings should then be taken in accordance with the table given in the previous article, May 5 number. Instruments for giving a direct-reading of insulation resistance are not designed to be connected to a winding in which current is flowing; therefore the generator should be quickly stopped, the insulation-resistance measured, and the field current again applied. It is advisable to place generator differential relays in service only after a machine is dry.

Rotary converters and direct-current generators and motors can be dried by operation on short-circuit with the shunt-field winding separately excited. In the case of rotary converters and direct current motors, a separate motor, usually belt connected, will generally be required to maintain rotation. Rotary converters can also be dried by low voltage, usually available from taps on the machine's transformers, applied to the collector rings with the armature blocked. To prevent a dangerous voltage in the shunt-field coils they should be short-circuited when this method is employed.

Field coils, if unassembled, can probably be best dried by hot air under forced draft. If they are in place on the machine drying may be done by applying current at a voltage from 60 to 75 per cent of normal. Changes in current in field windings and the like that are not dry should be made slowly to avoid the possibility of puncturing the insulation by induced voltage.

A common and effective medium for drying electrical equipment is dry, clean, heated air. Air may be heated by any method that does not mix the products of combustion with it: By hot water, steam, electricity, gas, oil, or even wood or coal. The limiting air temperature is 85 deg. C., and the volume of air should be such that the incoming and outgoing temperatures are nearly equal.

If a blower is not available heated air must be incased to provide a flue to maintain the draft. Heaters should not be placed directly beneath the equipment, but to one side of the flue, and a damper should be provided between the flue and the heater housing. The natural-draft method, while effective, is slow.

The forced-draft method is widely employed, particularly for transformers. Air is forced through a heater by a blower, usually operated by a motor, but occasionally by an internal-combustion engine. Heated air should pass through a baffle box to trap inflammable particles; thence to the equipment. A damper should be provided. Equipment being dried is generally housed in to make a passageway for the hot air, and various pipes and deflectors may be necessary to bring about a distribution of air that will insure uniform drying.

A portable dryer that has proved effective consists of a blower direct-connected to an induction motor. The air is forced through resistance grids and automatically maintained at desired temperature by a thermostat that, through a contactor, connects or disconnects the heaters on a 440-volt 3-phase circuit. Power required to heat air for drying may range from one to five per cent of the equipment's rating.

Oven drying is really a modified form of the natural-draft method, since there should be a circulation of air to carry away moisture. Ovens are generally permanent fireproof structures and are effective where equipment can readily be moved into them. Temporary ovens or drying housings can be constructed of almost any material, but metal or asbestos board should be used if available.

Drying in a vacuum is advantageous, since lower temperature may be employed, or the process hastened, but this method is rarely possible except in well-equipped shops or factories.

Space heaters or heating strips are useful for drying purposes. They may be placed in an oven, within or about a machine, or used to heat air in the same manner as resistance grids. The surface temperature of grids or space heaters may be 500 deg. C.; therefore care must be taken to see that these heaters are not placed too close to insulation or other inflammable materials. Oil must not be allowed to drip on to heaters.

Windings that are not too wet may be dried by current at low voltage. However, insulation that has become saturated may carry current if even low voltage is applied. In such cases drying should be done with external heat.

Low-voltage alternating-current can be obtained from an isolated generator, or by using transformers. Where an available voltage is nearly correct it may be boosted or bucked by transformers. A wide range of current can generally be obtained from limited transformer equipment.

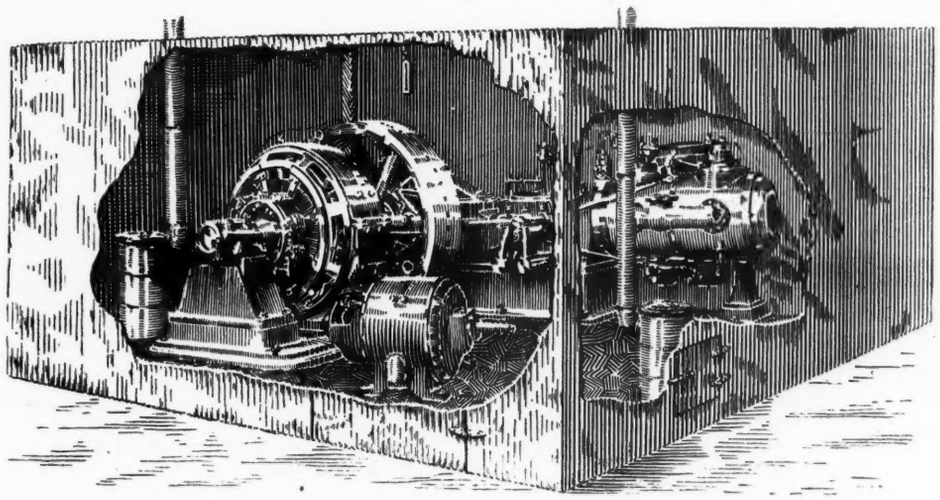
When windings are heated by current, it should flow through the entire winding to insure uniform drying. In some cases connections must be periodically alternated to accomplish this.

If polyphase current is employed to dry out a motor the rotor must be blocked if rotation is to be prevented. If insulated with fiberous materials the temperature of rotor bars must be kept below 95 deg. C. If direct current is available it may be circulated through motor windings to dry them. A special motor-generator will generally be required if direct-current is used.

Direct current for drying synchronous motors is recommended, although alternating current may be employed provided the collector rings are short-circuited to prevent a voltage dangerous to the field-winding insulation. In some cases synchronous motors may be dried by operation as an alternating-current generator on short circuit.

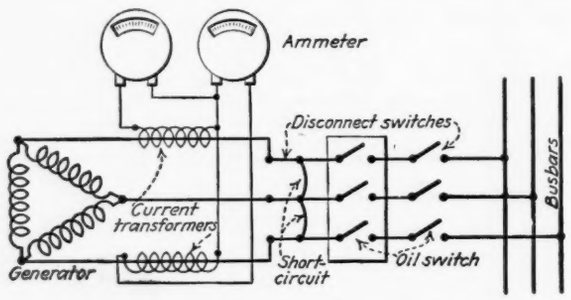
Voltage required to force heating current through a motor, generator or transformer depends on the impedance or resistance, and may range from 2 to 25 per cent of rated voltage. The current required may range from 25 to 125 per cent of full-load value.

Transformers, because they are generally operated at voltages higher than those of motors and generators, must be thoroughly dry before being placed in service.



This generator was flooded and was dried out by building a corrugated-iron inclosure around the unit and using two stoves to supply the heat. The stoves were fired through doors cut in the side of the inclosure. Motors that were also flooded were dried out by putting them in the oven with the generator

Measurements of the insulation resistances of transformers not immersed in oil may be interpreted the same as those of generators and motors. For insulation immersed in oil the parallel resistance of the solid material and the oil is indicated. The insulation resistance of either substance alone cannot be obtained. If the combined resistance is recorded when the solid insulation and the oil in which it is immersed is dry and it shows



Connections for drying out on alternator by the short-circuit method

any decrease, except that accounted for by temperature or atmospheric conditions, it indicates that moisture is present. Whether the oil or solid insulation is moist matters little, for in either case the moisture must be removed.

On two winding transformers three insulation-resistance readings are generally taken, namely, low-voltage to high-voltage windings, low-voltage winding to frame, and high-voltage winding to frame.

If the oil in a new transformer tests above 22 kv. between one-inch diameter electrodes spaced 0.1 in. apart, or if there is no evidence of moisture, such as drops of water or rust inside the tank, drying is probably unnecessary; but the insulation resistance should be measured as an additional check. Transformers that have been out of oil and exposed to the atmosphere for two weeks or more generally require drying.

Power, lighting and instrument transformers are, in general, best dried by hot air under forced draft, although natural draft can be used. Or, as is often done with power transformers, one winding may be short-circuited, and low-voltage applied to the other with the transformer out of oil.

Power transformers of the circular-coil core-type can best be dried by the short-circuited method with oil. This method possesses the advantages of incurring little risk of fire, and of bringing the dielectric strength of the oil up to a high value with little or no filtering.

With the short-circuit method in oil, moisture in the solid insulation is absorbed by the hot oil, and evaporated from the oil's surface. Before, or during, drying any free water must be drained from the oil. There must be sufficient ventilation to carry off the water vapor, and there should be 6 to 8 in. of space above the top of the oil.

To obtain the desired oil temperature transformer tanks may be blanketed, using building paper, canvas, or other materials. The temperature of the oil may also be controlled by reducing the flow of cooling water, or preventing oil circulation in radiators. Transformer covers must be well lagged to prevent condensation. Obviously, openings in the cover must be protected from the weather.

The percentage of full-load current that may safely be applied depends on the temperature of the oil in the top of the transformer, according to the following table:[1]

TRANSFORMER LOADING ON SHORT-CIRCUIT

Percentage of Full-Load Amperes		Allowable Top Oil Temperature in Deg. C.
Self-Cooled Transformers	Water-Cooled Transformers	
50	50	85
75	60	80
85	75	75

It is desirable to apply 50 per cent of full-load current and maintain the top oil temperature at 85 deg. C. If the oil tests less than 22 kv. it must be filtered before applying current to the transformer. Every four hours during drying samples of oil should be taken from the top and bottom of the transformer and tested, using the standard gap. Dryness is indicated after seven consecutive tests give breakdown values of 25 kv. or greater with the oil at maximum temperature for the current maintained and without filtering.

The oil may be filtered a few hours each day while drying, but this is not necessary, as the moisture is readily carried away if the cover is well ventilated. After drying, the oil level should be brought to normal by adding clean, dry oil. A high-voltage transformer should not be placed in service until all air bubbles have left the oil, and the oil has filled all voids, which may require ten or twelve hours.

Insulating oil readily absorbs moisture, and a small percentage of moisture will greatly impair its value as an insulation. The dryness of oil is determined by high-potential testing, the average of at least fifteen breakdowns being taken for each sample. Oil that punctures at 22.0 kv. should not be used.

Oil may be classified according to the following table:

GRADES OF INSULATING OIL

Grade	Average Kv. Withstood	Average Kv. to Puncture
Excellent	30.0	30.0
Very good	25.0	25.0
Good	22.5	22.5
Satisfactory	20.0	20.0
Doubtful	17.5	17.5
Unsatisfactory	....	....

Moisture may be removed from oil by heating, but a filter press or centrifugal purifier is commonly used to increase the dielectric strength of insulating oil.

Summary

1. Electrical apparatus having moist insulation should not be operated.
2. The dryness of insulating materials can be determined only by measuring the insulation resistance, for which a direct-reading instrument is most suitable.
3. The dry-out process should be carefully planned, and requires the services of competent men.
4. Fire and high temperatures are the greatest dangers, and must be constantly guarded against.
5. Data pertaining to dry out runs should be summarized in a report.
6. Drying may be done by hot air, or by current passed through the windings.
7. The best method depends upon local conditions and equipment available.
8. The short-circuit method in oil can be used to advantage with certain types of transformers.
9. High-potential testing should be done only at the factory.
10. Insulating oil must be dry and clean.

[1]From General Electric Company Publication GEH-58B.

Ash Loss Determination Facilitated by Chart

By C. H. Bean
Mechanical Engineer,
The Calco Chemical Co., Inc.

TO ENGINEERS responsible for the thermal efficiencies of stoker-fired boilers the graph here presented for the prompt determination of losses due to combustible left in the ash should be helpful. The only chemical or test data necessary to use the graph are quickly and cheaply obtained by sampling both the refuse or ash and the coal from which it came and testing both for ash and moisture. The moisture and ash in the coal must be determined or equated to the moisture condition as fired.

For example, the chemist's report on a sample of No. 3 anthracite buck coal may show:

	Per Cent
Ash	14.50
Moisture on sample burned for ash	0.89
Moisture on sample as fired	10.00

The true quality of the coal as fired is then:

$$\text{Moisture} = 10 \text{ per cent}$$

$$\text{Ash} = \frac{100 - 10}{100 - 0.89} \times 14.5 = 13.16 \text{ per cent}$$

Different kinds of coal have fairly well-known ash- and moisture-free calorific values. For instance, a low-volatile Eastern bituminous coal may run approximately 15,700 B.t.u. per pound; a high-volatile Eastern bituminous coal will run approximately 15,200 B.t.u. per pound; while a figure of about 14,700 is fairly accurate for most anthracites. The approximate heat value of No. 3 buck in this case is therefore:

$[100 - (10 + 13.16)]\ 14{,}700 = 11{,}295$ B.t.u. per lb.

The chemist's report on the refuse sample may read: Ash on dry basis = 85 per cent; combustible = 15 per cent. The combustible may be assumed to be pure carbon, running 14,500 B.t.u. per pound. The calorific value of the refuse is, then:

$$14{,}500 \times 0.15 = 2{,}175 \text{ B.t.u. per lb.}$$

If the amount of coal is known from which one pound of refuse or ash came, the quantity necessary to calculate the approximate loss due to combustible left in that ash is available. In this case there is 0.85 lb. of ash in one pound of refuse and there is 0.1316 lb. of ash in one pound of the coal. Therefore one pound of refuse came from,

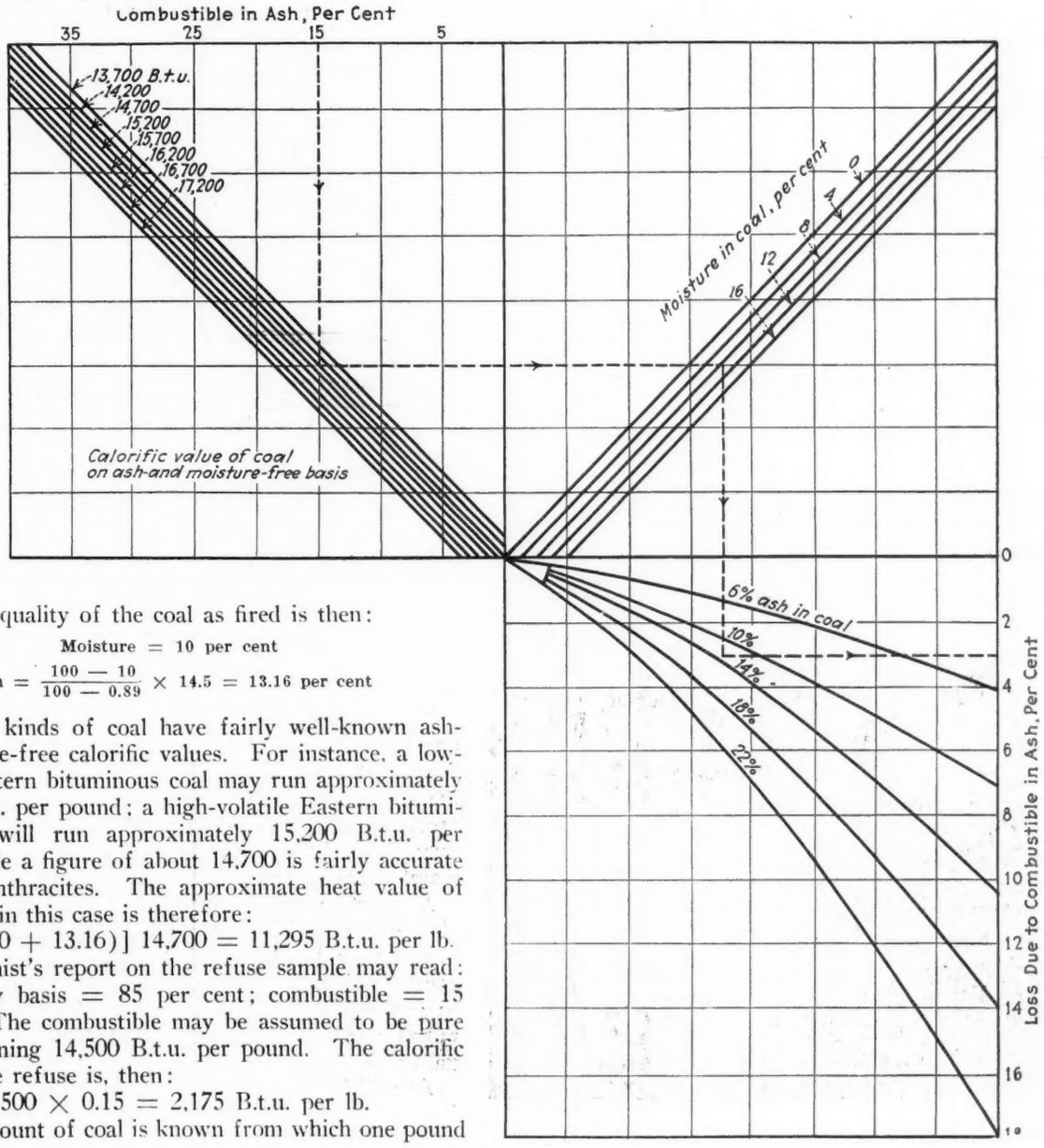
$$\frac{0.85}{0.1316} = 6.45 \text{ lb. of coal.}$$

The 2,175 B.t.u. in the pound of refuse came from 6.45 lb. of coal running 11,295 B.t.u. per lb., and the loss is

$$\frac{2{,}175 \times 100}{6.45 \times 11{,}295} = 2.98 \text{ per cent.}$$

Considerable figuring is involved in any of these calculations, but once done the result for any given kind and condition of coal and for any given quality of resulting refuse or ash in respect to combustible content can be plotted in the form of the accompanying graph. The dotted lines and arrows illustrate the procedure in reading such a result for the example previously calculated.

Results so obtained may not be exactly accurate, but they will answer as a practical operating guide.



Economy and Flexibility

Result from Plant Alterations

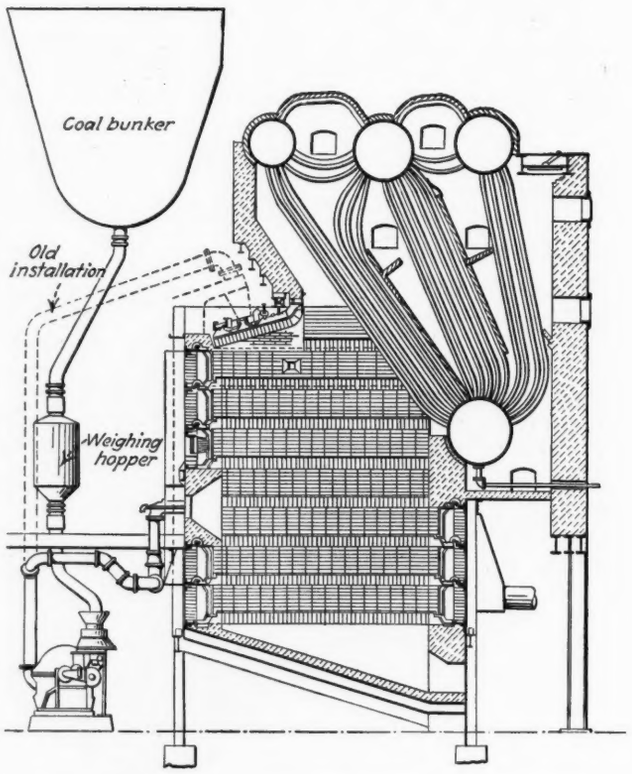
By PETER DIAS
Plant Engineer

AT THE power plant of the Essex County Hall of Records, Newark, N. J. (a description of which appeared in the Oct. 30, 1928, number of *Power*), a number of changes have been made recently to the boiler plant, and new equipment has been added. The alterations made to the steam-generating equipment were to obtain more flexible operating conditions with greater economy.

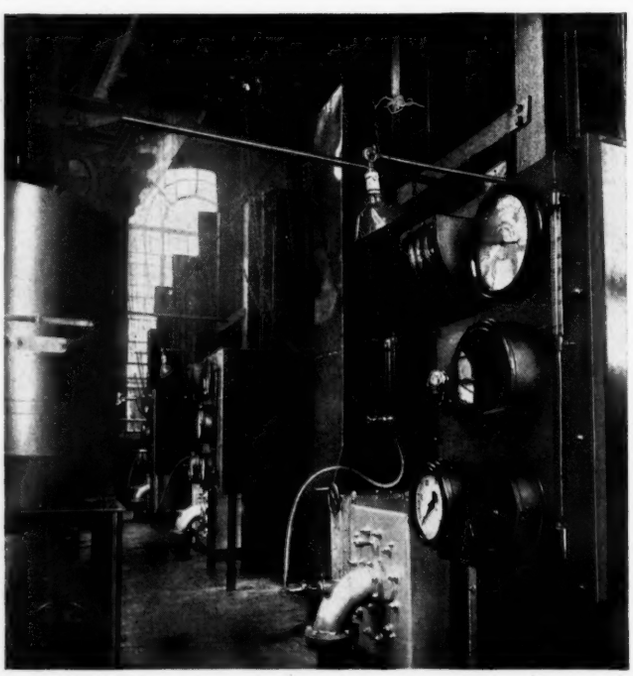
At this plant, which commenced operation Nov. 7, 1927, steam is generated by three 3,000-sq.ft. bent-tube boilers fired with pulverized coal. Light and power is supplied by three uniflow engine-driven units, with a gasoline engine-driven set for emergency auxiliary service.

Changes made in the air-cooled furnace walls of the three boilers to accommodate the new design of the Riley flare-type turbulent burner are shown in the accompanying sectional view. Originally vertical-type burners were placed in the arch at the top of the furnace. They were of the high-rate design and did not afford the flexible range necessary for variable-load conditions, especially light loads on Sundays and holidays.

The new horizontal-type burners are placed in the front wall just above the operating floor level. They are designed to meet any load condition ranging from 25 to 200 per cent of boiler rating without combustion difficulties. They have been operated with the Atrita pulverizers at sufficiently low ratings and have carried successfully summer loads varying from 5,000 to 18,000 lb. of steam an hour per boiler. Maximum capacity of the pulverizers is 2,500 lb. of fuel per hour, and minimum operating capacity has been 500 lb., affording a flexible range.



Cross-section of boiler showing original and present arrangement of burners and fuel piping



View of boiler room showing burners placed in front wall of furnace

It is the experience at this plant that successful operation of any pulverizer at extremely low ratings is largely dependent upon the ability to feed coal uniformly into the pulverizer. Now approaching its third year of operation, the unit's performance has been very satisfactory, from the operation viewpoint as well as from the maintenance cost per ton of coal ground.

A fourth pulverizer has been installed to make the plant more flexible. Fuel piping is arranged and connected with lateral valves to each burner, so that the fourth pulverizer can be operated and fuel conveyed to any one of the three boilers while the other three pulverizers, which are directly connected to the individual boilers, are in operation.

As will be apparent from the sectional view, fuel piping and valves are in the boiler-room basement, and the burners are on the operating floor. Rearrangement of

Principal New Power and Heating Equipment Installed

Additional Equipment, Hall of Records Power Plant

Unit pulverizer, Star Electric motor.....Riley Stoker Corporation
Apex CO_2 machine.....Uehling Instrument Co.
Air compressor, G. E. motor.Worthington Pump & Machinery Corp.
Permanent coal conveyors, two; Star Electric motor
Strowbridge Conveyor Co.
Portable coal conveyors, two; Star Electric motor
Strowbridge Conveyor Co.
Weighing hopper, Runyon & Carey design.....Meyer Scale Co.
Automatic coal sampler, G. E. motor.....B. F. Sturtevant Co.
Oil separator, Emerson motor.....DeLaval Separator Co.
14 in. Monarch lathe, G. E. motor.....Monarch Machine Co.

Service Equipment, Court House

Air compressors, two (temperature control; Emerson motor
Johnson Service Co.
Air washers, two; Type A.....Carrier Engineering Corp.
Fresh-air fans, two; Star Electric motor.....Buffalo Forge Co.
Ventilating fans, seven; Star Electric motor....Buffalo Forge Co.
Washer pumps two; Star Electric motor.....Buffalo Forge Co.
Vacuum heating pumps, two; G. E. motor..Nash Engineering Co.
Vacuum cleaner, G. E. motor.....Spencer Turbine Co.
Vacuum heating pump, steam-driven.....M. T. Davidson Co.
Service return pump, steam-driven.....M. T. Davidson Co.

Miscellaneous Service Equipment

Grease extractor, heating line.....Warren Webster & Co.
Back-pressure valves, two; 3 and 8 in.....Foster Engineering Co.
Vacuum pump governor.....Foster Engineering Co.
Reducing valves, three.....Foster Engineering Co.
Humidity controls, two.....Buffalo Forge Co.
Ozonator units, four; complete with Ozone generators and converters.....United States Ozone Co.
Steam piping, wrought-iron.....Reading Iron Co.
Pipe covering.....Charles B. Wood & Co.
Miscellaneous valves.....Jenkins Bros.
Radiator valves, modulation and sylphon type
Warren Webster & Co.
Clock system.....E. Howard Clock Co.
Heating, ventilating and additional power house work
George Stewart, Inc.
Electrical work.....Beach Electric Co.

the secondary air ducts and the air-cooled furnace walls in connection with the new burners affords a more uniform preheated temperature for both primary and secondary air. The original layout of the coal piping and burner is indicated by dotted lines.

The four pulverizer motors are wired for 110- and 220-volt operation. They can be operated at 1,200 r.p.m. on 110-volt current and field control, each motor being equipped with automatic starting speed regulators for 115 volts and arranged for 25 per cent speed control by field regulation. They are adjacent to the present 220-volt starters, and each is provided with push buttons for starting. In addition, four push buttons are connected to control the 110-volt and 220-volt starters from the boiler panel. Also, pilot lights adjacent to the push-button switches indicate when the pulverizers are in operation.

An electrically interlocking system has been installed on the coal-handling equipment, so that in the event of interruptions to any machine in the system the units ahead of it will stop. Pilot lights on this equipment indicate when the conveyors and coal crusher motors are in operation. There is push-button control for starting and stopping. Coal-weighing hoppers on the operating floor are equipped with an alarm system to indicate when the hoppers show a balance of 500 lb. of coal; the boiler operator then refills them.

Reconditioning of the County Court House was started Jan. 24, 1929, and it will be ready for occupancy about September of this year. The light, heat, and power requirements will be furnished by the "Hall of Records" power plant, which is housed in a separate building at the rear of the Hall of Records Building and is connected by a tunnel to both these buildings.

New equipment in the Court House basement is similar to that in the Hall of Records, and can be briefly reviewed as follows: All heating is done by direct radiation with a vacuum return system. Ventilating air is conditioned and maintained at 68 deg. In addition to the ventilating system, humidity controllers maintain a constant dewpoint as long as the wet-bulb temperature is below the dewpoint desired. Ozonators are also installed in connection with the two main fresh-air fans in the Court House and the three fans in the Hall of Records Building. The installation includes ozone generators, converters to change direct current to alternating current, transformers, blowers, dehydrators and regulators.

In the pump room a motor-driven automatic air compressor supplies air for power plant requirements and to the combustion-control equipment in the boiler room. The steam-driven air compressor originally installed is used only for higher air pressure needs. A complete oil-purifying system, including a centrifuge, cleans the lubricating oil of the generating units.

The temperature of the engine and boiler rooms dropped so low during the past two winters that it was found necessary to install three ventilating units in the engine room to circulate heated air from the direct radiation. Two unit heaters are used in the boiler room to supply the necessary additional heat. This is an unusual condition for plants of this size.

Ozone equipment is electrically interlocked with the fresh-air fan motors, so that starting and stopping of these motors will automatically start and stop the ozonators; an automatic cutout prevents starting of the ozone units when the dehydrators are being activated.

The air-conditioning equipment, temperature control, vacuum cleaning systems, ozone units, humidity equipment, heating return pumps, and various mechanical equipment are in the basement of the Court House. In addition to the motor-driven vacuum heating pumps, a steam-driven vacuum pump is designed to handle all the condensation from both buildings in case of an emergency and discharge it into a receiver and air-separating tank.

In the power house, and including the two buildings, all mechanical equipment is motor driven, with exception of the two steam pumps previously mentioned, one boiler-feed pump, and one air compressor. The boiler-feed pump is the only steam-driven equipment in service that is used evenings, holidays and Sundays; other steam equipment will be used for emergency purposes only.

Considering that the boilers are not equipped with superheaters or economizers, the evaporation, furnace and boiler efficiency obtained indicates good operation for a plant of this size. The evaporation averaged 11.38 lb. per pound of coal; boiler and furnace efficiency 79.55 per cent; and ratings from 160 to 175 per cent or normal. These averages are the net actual annual operating reports for 1929.

For these satisfactory operating results due credit must be given to the operating staff, the members of which had no previous experience with pulverized-fuel equipment, largely having been transferred from the hand-fired plant of the old Court House.

The author wishes to express his appreciation to the consulting engineers, Runyon & Carey, Newark, N. J.; to the plant superintendent, Henry H. Berg; and to the contractors for their co-operation in the preparation of this article.

Solving the

Human Equation

in the Power Plant

In the operation of a power system the human element is most important. Everyone concerned must constantly keep in mind his responsibility in preventing operating trouble. In this article the author, an operating engineer of many years' experience, gives his view on dealing with the personnel inside and outside the power plant

By RALPH B. DONALD

◆

IN THE generation, transmission and conversion of electric energy so much depends upon the human element that the greatest care must be exercised to select only competent men. Unless high standards are adhered to in their selection and training, avoidable interruptions to service are sure to occur.

It is a fact that after a few years many operating positions become irksome and monotonous. This is not so true of maintenance and construction work, because of its variety. Operating men should, therefore, be given the opportunity of transferring to more agreeable employment.

Many power failures are due to operating errors and neglect to properly maintain equipment. These failures cannot be charged to faulty or inadequate equipment. They are the result of negligence. Possibly a psychologist could devise tests whereby only those men who are naturally adapted to operation and maintenance would be employed, but generally the trained psychologist has no voice in this matter. Men usually are selected by the employment supervisor, or by the head of the department concerned. But a small percentage of the country's workers are required by the power industry, therefore high standards can be maintained.

Men selected for power plant and power system work should be in robust mental and physical health, energetic, intelligent, careful, quick and alert, possess a sense of responsibility, and be capable of sustained accuracy in thought and action. Few individuals have uncanny power to select men who possess most, or all, of these characteristics. A probationary period of three or four months is desirable for new men. No good comes of retaining men who do not measure up to reasonable and necessary standards of intelligence and ability. Men who are satisfactory should be expected and encouraged to prove loyal, dependable and permanent workers. There are no good reasons why operating and maintenance forces should be constantly changing.

Naturally, good working conditions are essential if the best operating performance is to be attained. Cleanliness of the entire plant, which can be brought about only by good housekeeping methods, surfaces kept painted in harmonious and attractive colors, adequate illumination, pure cool drinking water, comfortable room temperatures, well-ventilated wash rooms, ample locker space, absence of unnecessary noise, and well-kept grounds are factors that contribute to good working conditions. Other important factors are liberal wages, sick leave, pensions, annual vacations, not more than 48 hr. work per week, and a suggestion system paying suggestors a fair percentage of what their ideas are worth to the management. Promotions should be made from the ranks whenever possible.

Care must be taken to see that only such an amount of work is assigned to any individual that he can conscientiously and properly complete. There is sometimes an unfortunate tendency on the part of some supervisors to gradually pile work upon men to such an extent that they are "snowed under" during the following busy periods. When provided by the management, living conditions should be excellent, and there should be little, if any, interference with the personal affairs of workers. Means should be provided for properly educating children residing in company communities that are removed from towns or cities and therefore do not have the usual educational facilities.

GENERALLY, workers resent rules requiring them to appear in uniform, or, what amounts to the same thing, to wear prescribed attire. The management has the right to demand neatness in appearance. Therefore on some systems men are required to wear regulation clothing that generally costs no more than what would ordinarily be worn. All workers should take pride in their appearance. If the station is a show place, and men are continually in view of the public, suitable uniforms may be required. In such cases the management should assume the burden of increased cost over ordinary clothing. It is difficult to agree on a uniform suitable for the entire operating force, for while switchboard men might appear in gold braid and brass buttons, dungarees would be the most suitable attire for oilers.

In one hydro-electric plant most of the maintenance men were originally employed on the operating force,

which is a highly advantageous arrangement. It often happens, apparently for selfish reasons, that the management is unwilling to transfer to other work skilled operators and load dispatchers.

Reaction to an undeserved reprimand or to one unduly severe is always highly unfavorable. Unfortunately, reprimands are occasionally necessary, but they must be given in such a way that no just feeling of bitterness or resentment can linger. To maintain really satisfactory working conditions supervisors should have a sympathetic understanding of human nature and should practice tact, fairness, courtesy, and kindness. Intelligent, self-respecting men do not thrive on "hard-boiled" or roughshod supervision methods and executives should not tolerate such methods.

In all lines of activity we occasionally encounter individuals who are frequently meeting with mishaps and accidents. Generally such folk are unintentionally careless, absent-minded, hasty, and reckless. Their characteristics may not result in interference with service, but workers of this type are decidedly a potential source of danger in power plants. Unless after a fair trial they can overcome these defects, which actually constitute a menace to their safety and to that of others, as well as to service, such persons should have no part in operation or maintenance.

SAFETY FIRST is of extreme importance in power plants, not alone because of protection afforded workers, but safe conditions tend to improve operating performance. To be effective, safety-first activities must be unremitting, and should be carried on by permanent safety committees. The importance and extent to which safety first is to be practiced should be made clear to new men before work is begun. A booklet of safety-first regulations should be given them at this time. But booklets, bulletins, posters and slogans are not sufficient to make each individual practice safety first; the foreman or gang leader must see that the men with whom he is associated consistently follow safe methods. In fact, a foreman's most important duty is to prevent accidents. Each worker should be taught to safeguard himself, and, in so far as possible, his fellow workers. An efficient and effective clearance or hold-off card system is essential if equipment and men are to be afforded adequate protection.

Considering disturbances and interruptions, those resulting from errors made by operators or maintenance men, without damage to equipment, are most numerous. Such troubles are generally due to opening or closing the wrong switch, grounding a live circuit, energizing a circuit protectively grounded, or accidentally tripping equipment in operation. Fortunately, interruptions of this nature are usually of brief duration.

Many errors not only result in service interruptions, but also cause damage to equipment. Opening disconnects carrying current, connecting machines or systems that are not in synchronism, and attempting to work on energized equipment are among the more serious mistakes. These errors often cause long interruptions to service and occasionally personal injury or death. They cannot be attributed to inadequate or defective equipment, since there is a limit to the abuse equipment can stand. Synchronizing should be done automatically by devices long ago available. This is especially the case where rapid, frequent, and extremely accurate synchronizing is required.

During severe system trouble the operator may not be able to make a correct diagnosis of conditions in the limited time available, hence he is so handicapped as to make an error in judgment. It is important that all interruptions or disturbances to service be fully investigated as early as possible. Every pertinent fact bearing on the subject should be ascertained. If an investigation indicates that the operator is not fitted for his duties he should be transferred to other work. If there are extenuating circumstances that account for his failure, and the probability of a future failure appears remote, the operator's status should remain unchanged.

Discharge as the result of an error is rarely justified. Such an act may arouse ill feeling and affect adversely the morale of an entire operating force. A normal individual, an operator or maintenance man, whose action causes trouble will rarely be guilty of a second offense, whereas a new man may eventually meet with a similar or worse mishap. Experience generally is a good teacher. Discipline in any form must be administered with great care, otherwise its purpose will be entirely defeated. Suspension seems unnecessarily severe, for most men who make blunders fully realize their seriousness afterward, and regret them. A man who must be suspended to be made to realize the seriousness of operating errors has no place in a power plant.

It is important that power plant men realize that their own and the interests of the management are best served if the whole truth is told pertaining to any operating difficulty. Unfortunately, due to fear of unjust disciplinary action or loss of employment, there is sometimes a tendency to carefully conceal facts that the man at fault considers detrimental to his interests. This is a decidedly wrong feeling, regardless of the attitude of the management. Due to misdirected zeal, men in minor supervisory positions are sometimes too severe in administering discipline, especially where they may be partly responsible for the difficulty. Usually however, men in such positions are fair-minded. This applies particularly to major executives, who are sometimes inclined to be too lenient. Ordinarily, little publicity should attend the investigation of operating troubles resulting from error. However, if the error is of unusual nature, and caused far-reaching consequences, and is therefore of general interest, a bulletin may properly be issued stating the circumstances and pointing out the procedure that should have been followed to restore normal service.

PROBABLY not more than 2 per cent of operating errors are due to ignorance, lack of skill, poor training, inexperience, or the necessity for quick action. Errors in this class may almost entirely be avoided by rigid adherence to instructions and regulations, and occasional drills.

Some interruptions and disturbances are due to defective equipment. Plainly speaking, they usually result from sheer neglect in following proper maintenance methods, for most equipment will function properly if kept clean and in good condition. Adherence to a well planned inspection and maintenance schedule is thus of prime importance.

Finally, occasional operating troubles result from inadequate equipment. As an example, due to system or station growth, or to the absence of suitable reactors, oil circuit breakers may fail to rupture short-circuit currents. Good operating performance cannot be expected from overloaded or unsuitable equipment. Constant vigilance is necessary to prevent points of weakness because of system growth or obsolescence of equipment.

. . . RIGHT OUT OF THE PLANT . . .

Simple Ground Detector for Industrial Plant Use

I SHOULD LIKE to call attention to a phase of industrial plant operation that does not seem to be receiving the attention it warrants; namely, the detecting and locating of grounds on electrical equipment. In plants using 440- or 550-volt, 3-phase power for motors a simple ground detector may be constructed at little expense. Yet out of a number of factories I visited from time to time only two had any means of ground detection, and these were so placed as to be practically useless for attracting the attention of the operating staff.

At the industrial plant where I am employed a large number of motors is installed, the machines varying from ¼ to 200 hp. Grounds were frequent, and as there was no detector to tell the tale burnouts were also frequent.

One one ocasion five machine-shop motors, varying from 30 to 75 hp., burned out simultaneously soon after starting, with the result that several hundred men had to be sent home, with consequent loss of production. On another occasion a frame traveling through an electric drying oven on a chain conveyor toppled over and grounded the line bus to the heating units. This weakened the insulation of two 75-hp. motors, which blew out shortly after. A ground detector on the power system could have prevented these troubles.

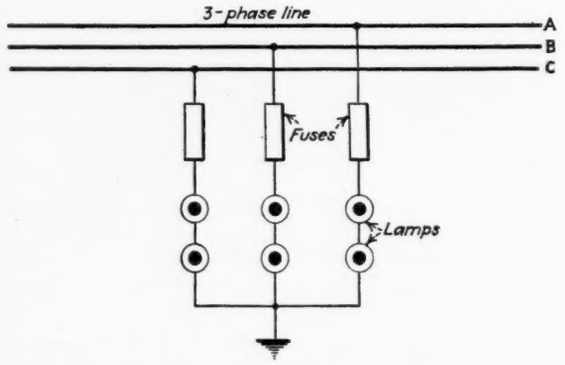


Diagram of connections using lamps to indicate grounds on motor circuits

In this connection, the value of a Megger for insulation testing cannot be overestimated, but as it can be used only when apparatus is shut down, and as grounds are likely to come on at short notice, it does not compare, in my opinion, with a detector properly installed and intelligently used.

Soon after taking charge of the electrical department in a plant I constructed a simple ground detector using 250-volt 16-candlepower carbon lamps, two in series, star connected, with a 1-amp. fuse in each line. The star point was connected to a permanent ground, as shown in the illustration. A steel cabinet was used. The fuse cut-outs were mounted inside, and the lamps were mounted on the lid with sign receptacles. It was installed on the wall in the electrical office in a prominent position. A portable detector on the same principle, but mounted in a wooden box with carrying handle and 20-ft. extension leads with insulated clips at the ends, was also made to locate trouble on the distribution lines.

A ground coming anywhere on the system will be indicated on the lamps. For example, a resistance ground will be apparent by the uneven burning of the lamps, and a dead ground on one line will cause two lamps to go out and the others to burn brightly.

As soon as a ground is noticed on the lamps, all feeders that can be dropped out without serious inconvenience to production are opened and closed, one at a time. If the fault is not located on any of these, the more important feeders are opened at noon or when work is finished for the day. As soon as the feeder on which the fault has developed is found, a trouble shooter starts out with the portable detector and traces down the fault by opening the sub-circuits while the portable is clipped on the line. In this way the ground is quickly found and the faulty equipment taken out of service and repaired. It is a simple device, but it has saved the company thousands of dollars for repairs and loss of production.

It seems to be the general impression that the grounding of one line of a three-phase system is not in itself a serious matter, but in my opinion it is just the contrary.

A ground on the system puts a strain on all connected equipment and shortly will develop into a short circuit through weak points in other apparatus. This is often noticeable in the downtown section, where a number of small concerns are supplied from one transformer bank, but in different buildings, using one or two small motors each. One motor will develop a ground without the owner's knowledge, and if conditions are right and his neighbor's motor weak on insulation both motors will be burned out. This is borne out by the fact that the electric service department when receiving a call for a burned-out motor usually gets several calls in the same neighborhood at the same time for the same fault.

Toronto, Ontario. ELLIS MILLS.

Adapting the Boiler Room Bonus To the Industrial Plant

I AM MUCH interested in the several comments that have appeared on the boiler room bonus. At our plant we have given this subject a great deal of thought in the last two years, and have worked out the following plan, which we should like to submit to the readers of *Power* for their analysis and criticism, so that any weak spots may be brought to light and corrected. We have not

as yet paid out any actual cash to the power house employees on this plan, but we have had it in use for about one year to try to determine its practicability, and we find it comes nearer to fitting our own conditions than any other system we have heard of. The men themselves seem to be highly interested and try to lower the fuel consumption, as though they were receiving a cash return on their saving.

We are in the meat-packing business, and before putting our plan into operation we concentrated on our power production department over a period of about three months; then we picked out a period of twenty days of the lowest fuel consumption that we had ever attained. At that time we were using oil for fuel, and we arrived at the following factors.

Average approximate kill per day 758
Average gallons oil per kill-day 4,360
Average gallons per head killed 5.74

We were using a 19,000-B.t.u. oil at the time of observation, and were obtaining a combined boiler and furnace efficiency of 74 per cent, a net B.t.u. of 14,060 per pound of oil burned. We then arbitrarily deducted 0.74 gal. from the original 5.74 gal. per approximate head killed, leaving 5 gal. net per head killed. We worked out the following formulas, giving the men an assumed credit of 25 per cent of the savings effected.

B.t.u. content of one pound of oil = 19,000.
Combined boiler and furnace efficiency = 74 per cent.
B.t.u. available in one pound of oil = 19,000 × 0.74 = 14,060.
Weight of one gallon of oil = $7\frac{1}{2}$ lb.
B.t.u. in one gallon of oil = 14,060 B.t.u. × $7\frac{1}{2}$ = 105,450.
B.t.u. per head killed = 5 × 105,450 = 527,250.

In our case this should be the basis on which the bonus is granted, regardless of whether we are burning oil, gas or coal, and it can be figured by the following formulas for this plant:

$$\text{Pounds oil per approx. head killed} = \frac{527{,}250}{14{,}060} = 37.5.$$

Application of Formula for Oil

Approximate head killed × 5 = *gallons oil scheduled.*
Gallons oil scheduled — gallons oil burned = gallons oil saved.

$$\frac{\textit{Gallon oil saved}}{42} = \textit{barrels oil saved.}$$

$$\textit{Bonus per man} = \frac{\textit{Barrels oil saved} \times \textit{cost per barrel}}{\textit{Number of men participating}} \times \frac{25}{100}$$

Natural Gas

B.t.u. per cubic foot of gas = 1,000
efficiency, per cent = 80.
B.t.u. available = 1,000 × 0.80 = 800.
B.t.u. per approximate head killed = 527,250.

$$\text{Cu.ft. gas per approx. head killed} = \frac{527{,}250}{800} = 659.$$

Application of Gas Formula

Approx. head killed × 659 cu.ft. = *cu.ft. gas schedule*
1,000's cu.ft. of gas scheduled — 1,000's cu.ft. gas burned = 1,000's cu.ft. gas saved

$$\textit{Bonus per man} = \frac{\textit{1,000's cu.ft. gas saved} \times \textit{price per 1,000 cu.ft.}}{\textit{Number of men participating}} \times \frac{25}{100}$$

Coal

B.t.u. per pound of coal = 11,500
Boiler and furnace efficiency = 60 per cent
B.t.u. available = 11,500 × 0.60 = 6,900
B.t.u. schedule = 527,250

$$\text{Coal per approx. head killed} = \frac{527{,}250}{6{,}900 \text{ B.t.u.}} = 76.4 \text{ lb.}$$

Application of Coal Formula

$$\frac{\textit{Approx. head killed} \times 76.4}{2{,}000} = \textit{tons of coal scheduled.}$$

Tons coal scheduled — tons of coal burned = tons of coal saved.

$$\textit{Bonus per man} = \frac{\textit{tons coal saved} \times \textit{cost per ton}}{\textit{Number of men participating}} \times \frac{25}{100}$$

As this plant kills on Saturdays only rarely, we made a close check over a period of time and determined that our net average fuel consumption was 81 bbl. of oil for this day. We therefore use the following formulas on Saturday:

81 *barrels* = 358,846,350 *B.t.u. for the day, or* 3,403 *gal.*
Gallons oil scheduled — gallons of oil burned = gallons oil saved.

Barrels oil saved = gals saved ÷ 42

$$\textit{Bonus per man} = \frac{\textit{Barrels oil saved} \times \textit{cost per barrel}}{\textit{Number of men participating}} \times \frac{25}{100}$$

Saturday Formula for Coal

$$\frac{\textit{Tons of coal required} = 358{,}846{,}350 \text{ B.t.u.}}{6{,}900} = \frac{52{,}006 \text{ lb.}}{2{,}000} = 26.$$

Tons coal scheduled — tons coal burned = tons coal saved

$$\textit{Bonus per man} = \frac{\textit{Tons coal saved} \times \textit{cost per ton}}{\textit{Number of men participating}} \times \frac{25}{100}$$

Saturday Formula for Gas

$$\textit{Cu.ft. gas required} = \frac{358{,}846{,}350 \text{ B.t.u.}}{800 \text{ B.t.u.}} = 448{,}558$$

1,000's cu.ft. gas scheduled — 1,000's cu.ft. gas burned = 1,000's cu.ft. gas saved

$$\textit{Bonus per man} = \frac{\textit{1,000's cu.ft. gas saved} \times \textit{cost per 1,000's cu.ft}}{\textit{Number of men participating}} \times \frac{25}{100}$$

For Sundays we require 309,390,903 B.t.u., and the amount for each fuel and the bonus per man was computed the same as for Saturday.

Before this system of checking fuel consumption was adopted we experienced considerable trouble from extreme fluctuations in the quantity of fuel burned each day. Since adopting this method, we can calculate closely, the first thing each morning, the fuel consumption for the day by determining what the kill is going to be.

We are submitting this with the full knowledge that it is not the perfect or ideal plan, but with the thought in mind that some reader may have a similar or more practical method of applying the bonus; and by discussing it through the pages of *Power*, it may be helpful to us as well as to other readers.

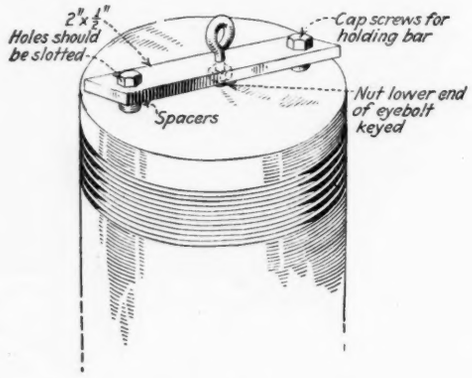
Although we have found the CO_2 method unreliable, we could not think of doing without the CO_2 machine in connection with the foregoing plan.

W. A. Schwerin, *Master Mechanic,*
Hygrade Food Products Corp.,
Topeka, Kan. Wolff Division.

Replacing Pistons in Diesel Engines

IN THE Feb. 18 number there was an article on "Replacing Pistons in Diesel Engines," and a method of using sash cord to compress the piston rings was illustrated and described.

In our plant we use a ring guide supplied by the engine manufacturer for compressing the rings. If guides are not standard equipment, they may be made at a local



Bar used for slinging Diesel pistons

machine shop. The small end of the ring guide should be the same size as the top of the cylinder bore, with a widening of the bore of the guide to the size of the piston ring when released from the cylinder.

For handling pistons we made a lifting bar, which we find better than eye bolts and a sling. The bar is of strap 2 in. x ½ in. and of a length that it will fit inside the cylinder, allowing ¼ in. at each end to clear the cylinder walls. The illustration shows the bar attached to a piston.

W. L. DINGWALL.

Cedar Rapids, Iowa.

How Some Corrosion Troubles Were Solved

MUCH has been written concerning the pitting and corrosion of pipes, boilers, and various other pieces of power plant equipment. Recently my attention was called to an interesting experience along this line. A steam turbine plant using sea water in its condensers was having a great many condenser tube failures due to pitting. The trouble seemed to be confined to the first one or two feet of tube surface on the inlet end; in fact, little deterioration was found at the center or outlet ends of the tubes.

After several remedies had been tried with little success, a representative of a paint company was called in. He recommended an application of a protective coating. While the paint man's proposition was being considered it became necessary to overhaul the circulating pumps and suction lines, and almost immediately a decided decrease in tube failures was noted, so much so that the salesman will probably lose a big sale. The theory has been expressed that the trouble was caused by a leaking packing box on the centrifugal pumps or air leaking into the suction lines, and that the pitting was the result of the oxidizing effect of the air brought into the condenser with the circulating water. When the circulating pump and suction line were repaired, the air leak was fixed, thus removing the cause.

I am inclined to believe this theory to be correct, from experience I have had with calcium chloride brine, which is less corrosive in action than sea water, but when mixed with air through a leaking packing box, or other manner, becomes corrosive, apparently due to the presence of the air and free oxygen—governed by the same laws as boiler and condensate line pitting or corrosion.

I have experienced difficulty from excessive pitting and corrosion in a 100,000-gal. water storage tank. When the corrosion was first noticed the tank had been in use about two years, and the upper half, alternately wet and dry because of the intermittent operation of the supply pump, was showing definite signs of corrosion. The water supply is from a deep-well pump, some of the lubricating oil of which mixes with the water and collects on the upper tank plates. As a remedy, we sand-blasted the entire side of the tank, and applied two coats of asphaltum paint. But in a surprisingly short time we found that the corrosion was again at work. The rapidity of the action was such that we believe that air or free oxygen could not be the entire cause. It was discovered that the water coming from the well contained considerable sulphur gas. This gas is liberated from the water upon reaching the tank, and no unusual amount of corrosion is found at any other point in the entire system.

We are of the opinion that the sulphur gas was the main cause, which may have been aided by the presence of the emulsified oil, which, no doubt, had a bad effect on the paint. The only remedy we have found for the problem is the application of a ⅛-in. coat of a special coal tar product, applied at a temperature of approximately 400 deg. This material hardens as soon as it comes in contact with the cold plates, and does not soften under normal temperatures. The plates must first be thoroughly cleaned with gasoline or a sand blast. A special primer coat is then applied, which acts as a bond between the steel and the protective coating.

A. C. MCHUGH, *Chief Engineer,*
Norwalk, Calif. Norwalk State Hospital.

Lawn Sprinklers Effective in Decreasing Station Temperatures

A HYDRO-ELECTRIC power company in the Southeast recently confronted with the necessity of decreasing the station temperatures during the hot days of summer found that satisfactory results could be obtained by the use of ordinary lawn sprinklers.

Several sprinklers of the revolving type were installed on the roof of the power house, being placed in such a manner that practically the entire surface of the roof was covered by the spray. The water supply was obtained from the transformer cooling water system, which is taken directly from the penstock.

By this method a condition closely approaching a continuous light rain was obtained, the sprinklers being allowed to operate continuously throughout the summer. The roof, dampened and cooled by water, formed an excellent medium for cooling the air within the station.

Results proved that even during the hottest days the reduction in temperature was appreciable within the station. Generally, the station temperature ran equal to or slightly less than the temperature of the outside air.

Maryville, Tenn. C. B. STOUGHTON.

New Trends in Refrigerating Industry

Discussed by Engineers at Atlanta

New developments that are exerting an increasing influence upon plant design and operation were featured at the annual spring meeting of the American Society of Refrigerating Engineers. More than 100 delegates attended the convention. Technical sessions were held during the mornings of May 7, 8, and 9, and sightseeing trips to Stone Mountain and to outstanding plants were held in the afternoon.

THE MEETING was opened with a paper by H. D. Edwards on "Low-Temperature Refrigeration." It covered various problems of refrigeration when low temperatures must be maintained. In a paper by F. W. Rabb, Anheuser-Busch, Inc., on "Tests of Solid CO_2 and Water Ice" the author gave results of a number of tests on relative effects of CO_2 and water ice. Apparently, for many specific applications CO_2 is more efficient and less expensive in cost of a unit effect, even though the price per pound is much higher than that of water ice.

Mention was made of a new design of ice cream and cold storage truck in which CO_2 is being used as the refrigerant. To prevent the frosting and dripping that occurs when CO_2 is used directly, one pioneer has suggested two refrigerants, with the CO_2 acting as the condensing medium for the second refrigerant.

Discussion indicated that, in general, engineers feel ice packing of delivery packages will disappear in time.

"Latent Heat of Foods," by A. H. Cooper, covered a discussion of the method used by the author in ascertaining the latent heat of fusion of various foods.

At this session two other papers "Low-Temperature Refrigeration for Retail Merchants," by R. E. Ottenheimer, and "Low Temperature Display Cases," by G. J. Hopkins, covered the requirements of food display cases needed to properly care for and display cold storage products in retail stores. These papers were of interest chiefly to food purveyors.

Wednesday afternoon was taken up by a trip to Stone Mountain, preceded by a luncheon at which Professor W. R. Woolrich, University of Tennessee, spoke on "Training of Refrigerating Engineers." The speaker pointed out that modern education is along lines entirely different from those urged by the ancient philosophers. Their teaching was purely cultural, with no practical application made of those laws discovered by the wise men of the day. Now education is almost entirely directed toward the application of physical laws. The speaker felt that this was a failure, and that engineers should be given a broader cultural background.

Those who intend or contemplate entering the refrigerating engineering field should take a broad engineering course, and the speaker felt that refrigerating engineering was not a proper basic course in any college. Students should not be encouraged to specialize while in college. If after finishing the usual four-year course a graduate desires specialization, then he should do post-graduate work.

AT THE Thursday morning session "Automatic Refrigerating Controls" was covered in a paper by C. P. Goree, of the Frick company. This paper dealt with various types of ammonia liquid control valves and their actions. Two general systems are in use. Valves of the first class are of the float or diaphragm types so connected that they drain the high side and store all the liquid in the evaporating side, and some form of liquid separator is needed to prevent liquids reaching the compressor. The second class embraces designs wherein the float valve controls the flow of liquid so that the demands of the evaporating coils are met but not exceeded. The author favored this latter type. Various valves and layouts were shown in slides. The use of control valves in small plants was highly recommended as eliminating almost all the labor costs and making the automatic plant a possibility.

Considerable discussion of the application of the A.S.R.E. test code for rating commercial refrigerating units took place at the Thursday morning session. The difficulty of establishing a standard method of rating such units that will be accurate from an engineering point of view for widely varying systems, ranges, and applications, and at the same time have a definite comparative value for the average purchaser, was brought out. It was the consensus of opinion that it is necessary to divide such ratings into three distinct groups: precise technical comparisons such as have already been set up for the large-capacity machines; a more simple, yet no less rigorous, rating of the unit in B.t.u. or ice-melting effect over a certain period of hours with a specified room temperature of 80 deg. F., and a low-side pressure corresponding to the vapor pressure of the refrigerant at 5 deg. F., for the smaller commercial machine, and a directly comparable over-all rating, including unit and case, for clarifying domestic refrigerator claims.

"Vacuum as an Insulator," by C. O. Duevel, Jr., dealt with the action of a vacuum space as a heat insulator, proper constants being given. Interposition of a space of still air or of a vacuum will reduce radiation losses by half and largely eliminate other losses.

In a vacuum space filled with gas the conductivity is found to be constant regardless of gas pressure. This holds for all but very low pressure, or very high vacuum. Under the latter condition, the amount of heat transferred varies directly with the pressure.

FRIDAY MORNING "Aspects of Refrigeration in Candy Manufacture" was covered by Tresper Clarke, Nunnally Company. Originally, the speaker pointed out, refrigeration was applied to chocolate cooling by brine coils suspended in the workroom. As a result the atmosphere was damp. Then direct-expansion coils with forced air circulation was tried. Air-conditioning and humidity control systems are now superseding the older systems.

J. B. Churchill presented a paper on "Practical and Ideal Refrigerants," dealing with various chloride refrigerants used in household machines. He gave result of tests run by the Bureau of Standards. The speaker claimed that these tests indicate that methyl chloride is not toxic even if food absorbs 1 per cent of its weight of gas. Experiments indicate that a new chemical when added to methyl chloride makes the latter so irritating that any sleeper will awaken if a leak develops in the refrigerating system. Mention was also made of a new refrigerant, carbon-bichlorine-biflorine, which is non-toxic, but it has the disadvantage of being highly corrosive in the presence of water, due to the liberation of one of the chloride radicals, resulting in the formation of hydrochloric acid.

At the banquet, which was attended by about 200, Lewis F. Gordon gave an address on "The Industrial South." The speaker gave data on the growth of manufactured products in the South compared to that of the entire country. He claimed that the South is entirely self-sustaining, as it manufactures all articles entering into every-day consumption.

From Among Readers' Problems

Conducted by

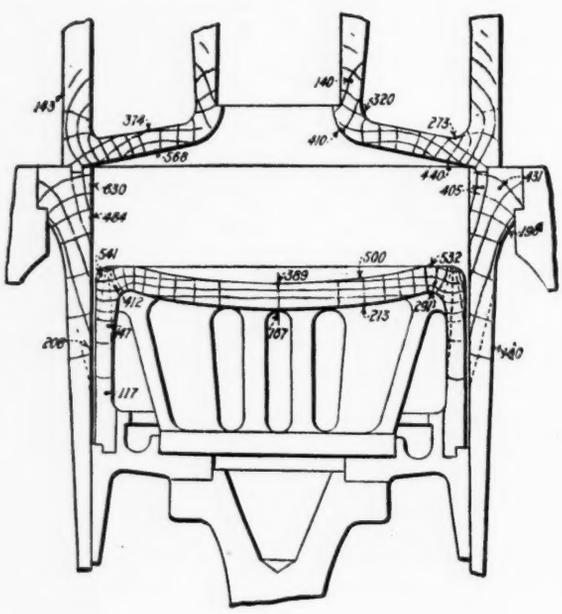
L. H. MORRISON

AMMONIA - COMPRESSOR COOLING JACKET—*Why are not ammonia-compressor cooling jackets made the entire length of the cylinder instead of merely extending down half way?* G.G.

The temperature of the ingoing-jacket cooling water is never lower than 60 deg. F. The suction vapor is always below this value, say zero degrees. If the jacket extended the entire length of the cylinder, the suction gas after entering the cylinder would actually absorb heat from the jacket due to the 60-deg. temperature difference. As the piston compresses the ammonia vapor, it warms up and reaches 60-deg. temperature around one-half stroke. Because the cooling jacket is started at this point, the jacket water absorbs heat from the gas during the remainder of the stroke, where the work of compression increases the temperature of the gas much above 60 degrees.

CYLINDER WALL TEMPERATURE IN DIESEL ENGINE—*Have there ever been tests run to find the temperature at the surface of a Diesel cylinder liner?* J.R.M.

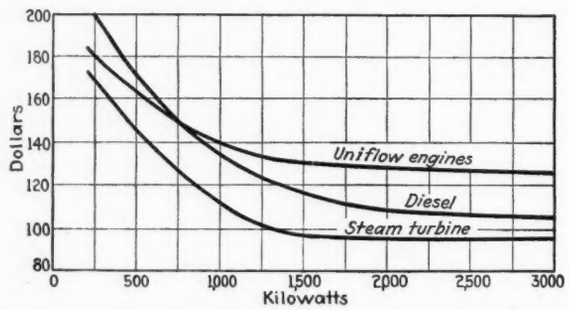
Sulzer Brothers several years ago ran a series of tests, using delicate thermocouples located both in the piston and in the liner walls. Temperature readings thus obtained are shown in the illustration. It will be seen that the wall temperature is high on the combustion-space surface, but is low at points below the piston position, due to the protection afforded by the latter.



Cylinder wall temperatures as found in test conducted by Sulzer Brothers on a two-stroke-cycle Diesel

RELATIVE COST OF POWER PLANTS—*What is the relative cost of a 500- and a 1,000-kw. plant equipped with uniflow engine, steam turbines or oil engines?* C.M.

Costs vary with the fancies of the plant designer, as well as with the type of fuel to be used and pressure to be carried. The illustration shows relative costs of the three types of plants; both the turbine and uniflows are condensing and the steam pressure is 250 lb. with 100 deg. superheat. It must be remembered that some particular plant may be 50 per cent off for the curve. These cases do not include the building.



CAKING OF SOOT FROM USE OF STEAM-TUBE CLEANER—*In using a steam-tube cleaner for tubes of a return-tubular boiler, we are troubled by the steam converting the soot into a paste that quickly becomes baked hard and cannot be removed with a flue brush or scraper. Could not the difficulty be overcome by blowing out the tubes with compressed air?* C.B.C.

The trouble could be obviated by using compressed air provided a sufficiently large supply of dry air at high pressure is available for the operation. Caking of the soot in the tubes results from moisture that is driven out of the fuel or discharged from the steam tube cleaner, and there will be less of this trouble from the steam tube cleaner if, before use, any water gathered in the hose or other connections is thoroughly blown out and the cleaner is supplied with dry steam.

CHATTERING IN ALTERNATING-CURRENT MAGNET SWITCHES—*The no-voltage release coil on some types of starting compensators and occasionally the magnetic contactor switches on some motor controllers make a loud humming or chattering noise. What is the cause of this trouble and what can be done to correct it?* J.T.H.

Humming is a defect inherent in all alternating-current magnet switches, due to the alternating flux in the iron core. It may be caused by loose laminations. However, when particularly loud it can usually be traced to vibration of the armature, which drops slightly away from the polepieces at each alternation as the flux passes through zero, to be pulled back again when the flux has reversed. Most manufacturers add shading coils, or large copper rings inclosing a portion of the pole face, which produce a small field out of phase with that due to the main coil. The shading-coil field holds the armature while the main field passes through zero. But if the armature is out of adjustment, so that it does not fit closely against the pole faces, the field produced by the shading coil becomes too weak to hold the armature, and considerable chattering may result. The only remedy is careful adjustment to give a better fit between the armature and the polepiece.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

IS IT safe to blow down the water walls of a 325-lb. boiler while the boiler is under load? C.A.MCC.

WATER WALLS are generally used in the newer types of boiler plants where the boilers are operated at fairly high ratings. Steam is generated in the water-wall tubes at unusually high ratings, owing to the tubes being exposed to radiant heat of the fire.

If water walls are blown down while the boiler is under load there is danger of burning the tubes of the wall, because opening of the blowdown valves sets up a current in the water box which counteracts the natural circulation of the water from the lower box up through the tubes to the top box, and steam bubbles may thus be formed next to the tube wall.

As is well known, steam is a much poorer conductor of heat than water, and the tubes, are insulated from the water by the formation of steam bubbles, will overheat, and blisters will be formed in the tube walls which eventually will result in failure.

Except in the case of plants using a poor grade of feed water and little or no water treatment, it will not, as a general rule, be necessary to blow down the water walls oftener than once a week, and even less frequently. Blowing down should be done with the boiler out of service, and when there is no pressure on the boiler and no fire in the furnace. After water walls have been drained the lower box should be flushed out with a water hose, and the walls filled with clean water.

PETER G. DAHL.
Elmwood Park, Ill.

SUCCESSFUL operation of water walls depends on maintaining rapid circulation, and it naturally follows that anything which might produce stagnation or interfere in any way with the circulation would result in burned tubes. This is especially true where the furnace temperatures are high. However, it is feasible to blow down the water walls while the boiler is under load, providing the blowoff valve is only cracked, for if this valve were opened wide the tubes, during the blowing down process, would have insufficient water, with consequent superheating of the steam that would be likely to result in burning the tubes.

W. E. GLENNON,
Chief Inspector,
Hartford Steam Boiler Inspection & Insurance Company.
Cincinnati, Ohio.

UNDER no consideration should one blow off water walls while they are in service at high pressure. Instead have a blow-off operated when the pressure is low, thereby preventing any chance of trouble. Of course, a mud drum could be blown off under this pressure, but not a water wall, as the water space is small and it is subjected to much higher temperatures. Therefore, to be safe, blow off only at a time when pressure is low; then there need be no fear of violating safety-first rules.

R. H. PARRISH.
San Antonio, Texas.

DANGER in this practice lies, of course, in overheating the water-wall tubes by high furnace temperature and insufficient supply of water to the tubes while blowing down.

In general, it is not safe. Boilers had best be banked and allowed to cool somewhat before blowing. More satisfactory lowering of the concentration will also be obtained during this period of slow water circulation.

Conditions under which this operation might be considered safe are those making for low metal temperatures of the water tubes. Freedom from scale, ample downcomer area to supply water to the tubes, low rating operation (while blowing) to give low furnace temperature, and small refractory area in the furnace, would all assist. Even so, it would be best to occasionally measure the tube diameter to detect possible enlargement.

Determination of furnace temperature, radiant heat transfer rate, tube metal temperature, and water velocity in the downcomers and out the blowdown valve would give a fair check on the possibilities of overheating the tubes.

R. H. SOGARD.
Topeka, Kan.

WHETHER it is safe to blow down water walls connected with a boiler operating at 325 lb. pressure depends upon a number of factors, such as quality or condition of the boiler water, size of tubes used in the wall, number and size of downcomers supplying the lower header with water from the drum, number of recirculating tubes, water head under which the wall operates, etc.

In some earlier types of wall construction trouble was had from tubes blistering and burning out in actual service owing to insufficient circulation at high ratings or bad water conditions. With walls operating under these conditions blowing down while the boiler was operating at fairly high ratings would be inadvisable. However, with the more improved wall construction, in which ample supply and recirculating tubes are provided, a wall either of the bare or armored type could undoubtedly be blown down at the higher rating without seriously disturbing circulation in the wall. Reasons are the more adequate provision made for water supply, and recirculation within the wall itself.

Even though it may be safe to blow down walls at the highest rating, it is not permitted in our plant. The blowing down is done when the boiler is out of active service.

R. E. LONG.
Philadelphia, Pa.

[Some water wall manufacturers recommend that walls be blown down only when the boiler is on bank or operating on a comparatively light load. Other manufacturers make definite recommendations against blowing down the walls while the boiler is in service.

Providing a good quality of feed water is used and regular test made of the concentration, there would appear to be little reason to blow down a wall with the boiler in service, inasmuch as the rapid circulation in the wall tends to prevent any material precipitation of solids in the lower headers.—EDITOR.]

A Question for Our Readers

WE HAVE recently purchased an evaporator, second-hand, suitable for an operating pressure of 75 lb. As our boiler pressure is 250 lb., it will necessitate the use of a reducing valve. Our master mechanic suggests installing the evaporator adjacent to one of the main turbine units and bleeding steam at the 75 lb. stage and discharging the vapor into one of the lower stages of the turbine instead of installing a special condenser for this purpose.

Would this be practical, inasmuch as the pressure would vary from 50 lb. at full load to about 20 lb. at light load, and the pressure in the stage at which the vapor would be admitted would range from atmospheric to about 10 in. of vacuum? E.P.S.

Suitable answers from readers will be paid for and published in the June 24 number.

Benson Boiler Tested At Charlottenburg

Based on a report by Von E. Josse, Berlin, published in the December 21, 1929, number of the *Zeitschrift des Vereines deutscher Ingenieure*, this digest gives the principal results of test of a Benson boiler installed at the Charlottenburg (Germany) technical school.

FEED WATER is pumped to the Benson boiler at pressures above the critical (3,200 lb. per square inch). Due to the addition of heat at these pressures, the temperature of the contents of the boiler rises continuously as the water changes into steam. There is no fixed dividing surface between the liquid and the steam, as there is in boilers operating at lower pressures. There is, therefore, no need of drums to separate water from steam. The evaporation in the Benson boiler takes place entirely in the tube coils, which are heated by radiation and convection.

The boiler erected at the Mechanical Engineering Laboratory at the Technical University at Charlottenburg was built by Siemens-Schuckertwerke, A.G., for experimental purposes. It has an evaporative capacity of 6,600 lb. of steam per hour at 3,260 lb. pressure and 842 deg. F. steam temperature.

The feed water first enters the economizer, which is made up of five coils arranged in series. Here the water is heated, to a temperature ranging from 248 to 338 deg., depending on output conditions. From the economizer the water flows into the radiation heating surfaces. The radiation coils directly surround the combustion chambers of the boiler. Here the temperature of the water rises to 698-715 deg. F., that is, to the neighborhood of the critical temperature of 706 deg. F.

The fluid passes from the radiant heating surface to a well-insulated line leading to the second convection heating surface, located back of the radiant surface. Here it passes into the region of superheated steam. It leaves the boiler through a stop-and-check valve.

The boiler is fired by two low-pressure oil burners. Feed water is condensate from the steam turbine, and is forced into the boiler by an electrically driven high-pressure triplex pump. The output of the pump is controlled by the speed of the motor. The air for combustion is preheated.

Dimensions of the heating surfaces are as follows: Initial convection surface (economizer) 265 sq.ft.; radiation heating surface 452 sq.ft.; convection heating surface back of radiation part (superheater), 370 sq.ft.; total, 1,087 sq.ft.; air preheater, 1,226 sq.ft. As the tubes of the radiant surface are close together, they are exposed to radiation on only one-half the circumference, thus giving an actual surface exposed to radiation of 226 sq.ft., although the total area of these tubes is 452 square feet.

As there is no high-pressure engine, the generated steam is used in a steam jet wherein the steam expands in a nozzle to 156 lb. pressure, is mixed with steam of equal pressure from another source, and is compressed in a diffuser for experimental purposes up to approximately 568 lb. per square inch.

The principal object of the tests was to find out the condition of the medium at various points in the generator, and at the same time to determine the boiler efficiency. Due to the fact that small errors in the measurement of pressure and temperature in the neighborhood of the critical point cause a substantial deviation in the heat content, the heat content of the medium itself was measured directly by means of calorimeters between the two radiating parts, and at the outlet of the second radiation part. At these points approximately 66 to 88 lb. per hour were withdrawn and conducted into the calorimeters by short well-insulated pipe lines. In the calorimeters copper-tube coils were surrounded by cooling water flowing in various directions. These calorimeters, which were calibrated by low-pressure steam, were accurate within one-half of 1 per cent.

The tests showed that steam does not reach the neighborhood of the critical condition before it leaves the radiation heating surface. This appears to be independent of the output. Between the two radiation parts the temperature was still considerably below the critical point. Heat contents at high pressures were taken from a special steam table prepared by averaging the results obtained by various investigators.

Aside from four tests which were made at various outputs, at approxi-

TABLE I—PRESSURE, TEMPERATURE AND HEAT CONTENT OF STEAM

	Test No. 1	2	3	4	5	6
Water or steam pressure, lb. per sq.in.:						
Boiler inlet	3,820	3,720	3,560	3,350	3,010	2,300
First radiation section inlet	3,535	3,580	3,465	3,280	2,825	2,145
First radiation section outlet	3,495	3,520	3,435	3,280	2,755	2,060
Second radiation section outlet	3,462	3,520	3,435	3,280	2,770	2,060
Boiler outlet	3,240	3,365	3,310	3,170	2,640	1,818
Water or steam temp., deg. F.:						
Boiler inlet	89.6	88.3	87.1	91.7	81.9	96
First radiation section inlet	244.2	284	286	338	246	311
First radiation section outlet	575	570	555	677	567	.....
Second radiation section outlet	715	716	713	705	682	640
Temp. at outlet of superheater, deg. F.:						
Coil 1	718	720	716	707	682	632
Coil 3	736	738	728	716	698	650
Coil 5	782	782	763	758	756	740
Boiler outlet	842	843	820	813	832	814
Heat content, B.t.u. per lb.:						
Boiler inlet	69	67.3	65.6	69.8	58.8	70.7
First radiation section inlet	225	264.5	266	322	223	288
First radiation section outlet	592	.....	563	742	572.5	656
Second radiation section outlet (calorimetric)	936	921	917	864	896	942.5
Heat content superheated steam, B.t.u. per lb.:						
Coil 1	971	945	955	.....	.....	.....
Coil 3	1,090	1,081	1,015	1,035	1,112	1,169
Coil 5	1,212	1,202	1,160	1,170	1,230	1,286
Boiler outlet	1,300	1,310	1,269	1,271	1,318	1,352

TABLE II—INPUTS AND FLUE GAS ANALYSIS

	Test No. 1	2	3	4	5	6
Feed water, lb./hr	6,130	4,850	4,030	3,230	5,200	4,810
Into calorimeter between radiation parts, lb./hr	61.7	.....	81.6	83.9	132.3	70.6
After radiation parts, lb./hr	95	.....	95	95	86	90.5
Steam per hr. second radiation section	6,068.3	4,850	3,948.4	3,146.1	5,067.7	4,739.4
Steam per hr. boiler outlet	5,973.3	4,850	3,853.4	3,051.1	4,981.7	4,648.9
Oil consumption, lb./hr						
Combustion chamber 1	251.5	.....	.....	190	226	202.8
Combustion chamber 2	251.5	.....	.....	96.6	220	195
Total	503.0	421	351.8	286.6	446	397.8
CO_2 content of flue gas at preheater outlet, per cent	10.6	8.7	7.5	5.5	9.5	9.1
Flue-gas temperature at preheater outlet, deg. F	509	457	466	430	484	406
Air temperature preheater inlet, deg. F	81.5	82.4	89.6	88.5	77	75.2
Preheater outlet, deg. F	496	444	455	453	460	384.5

TABLE III—AMOUNT OF HEAT TRANSMITTED AND EFFICIENCY OF BOILER

	Test No. 1	2	3	4	5	6
Heat transmitted, B.t.u. per hr.						
Convection surface before radiation part	953	953	810	806	858	1,049
Radiation section 1	2,248	....	1,200	1,365	1,810	1,770
Radiation section 2	2,085	....	1,391	381	1,649	1,350
Radiation total	4,333	3,192	2,591	1,746	3,459	3,120
Convection superh	2,170	1,795	1,353	1,241	2,090	1,910
Total	7,456	5,940	4,754	3,793	6,407	5,079
Supplied by Fuel, B.t.u. per hr.						
Upper heating value	9,840	8,260	6,880	5,610	8,720	7,790
Lower heating value	9,210	7,230	6,450	5,260	8,160	7,300
Boiler efficiency, per cent						
Lower heating value	80.9	76.8	73.8	72.3	78.5	83.4
Higher heating value	75.8	72.0	69.0	67.6	73.5	78.1

mately 3,260-lb. pressure and 842 deg. F., at the boiler outlet, two tests were made at pressures below the critical (2,640 lb. and 1,818 lb., respectively.)

Since the boiler was in operation several hours before each test was made, it may be assumed that it was in a fairly steady condition, particularly considering the comparatively small amount of wall protection and water content. The steam temperatures of the boiler output varied only a few degrees during the tests. Steam pressure was maintained by means of stop valves.

Table I shows the measured pressures and temperatures, as well as the calculated heat content. Table II shows the consumption of fuel oil, the weight of the feed water, and the amount of steam drawn into the calorimeter. The fuel oil used showed an upper heating value of 19,560 B.t.u. per pound, and a lower heating value of 18,300 B.t.u. The carbon content was 86.22 per cent, and the hydrogen content 12.89 per cent.

The heat transmitted per hour to the various parts of the heating surface are computed in Table III, together with the efficiency.

When criticizing the results, it should be remembered that the boiler is an experimental unit with a small capacity of 6,600 lb. per hour, and has a large radiating surface compared with the amount of heat transformed. The heat losses by radiation and convection would be smaller in a larger boiler.

The tests showed that at constant load the steam condition at the outlet remains the same almost without attention.

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Coal Consumption Decreasing, Water Power Increasing in Brazil

AVAILABLE data concerning fuel and power in Brazil, as given by J. R. Bradley in the March 10 number of *Commerce Reports*, indicate that proportional to the total quantity of coal, oil fuel, and water power available, coal consumption is decreasing (the percentage from domestic production is about stationary), oil fuel is about stationary, and water power is making phenomenal headway.

In 1913 practically all of Brazil's fuel and power, excluding that from wood, was derived from imported coal. There is no record of developed water power at that time which, however, probably exceeded 100,000 hp. Coal produced locally and imported oil fuel, in terms of coal, accounted for less than 1 per cent of the coal and oil fuel available for consumption. In 1920, however, of the total coal, oil fuel and water power, in terms of coal available for consumption of 3,425,000 tons, coal accounted for 45 per cent, of which about 20 per cent was of domestic production, oil fuel for 11 per cent, and water power, calculated at 6 tons of coal as the equivalent of 1 horsepower-year, for 43 per cent.

In 1924 coal supplied 40 per cent, of which 16 per cent was from domestic production, oil fuel 9 per cent, and water power 51 per cent. And in 1928, the figures were 37 per cent, (domestic coal about 16 per cent), 8 per cent, and 55 per cent, respectively.

A conservative estimate places Brazil third among the countries of the Americas, and of high rank among the leading countries of the world, in its resources of water power, of which but 5 per cent has been developed.

Within commercial distance of transmission of electric power the sources of water power are very large. Some time ago the Federal Department of Transportation and Public Works stated that there are 378 important falls in Brazil, only 154 of which had been roughly measured. The 154 falls have a potential horsepower of 50,000,000, and it is estimated that the remaining 224 will bring this figure to a minimum of 60,000,000 hp., or 44,000,000 kw. Preliminary estimates of the Geographic Survey of Brazil differ, however, and give available power estimated at 12,879,000 hp. at minimum flow, most of which is located in sparsely settled regions.

About 65 per cent of the 640,000 hp. developed at the end of 1928 was centered around Rio de Janeiro and Sao Paulo. The region around San Paulo is the most highly industrialized in South America—attributable to the developing of hydro-electric power. It has been estimated that 50 per cent of the total population of Brazil is within 500 miles of Rio de Janeiro.

Why Hot Water Radiators Do Not Heat

THE PRINCIPAL cause of cold hot-water radiators on the end of a line is the high pressure built up in the return main by the radiators nearer the heater. This fact is so important that to ignore it is to invite almost certain failure in some parts of the system.

To make the flow in a radiator start in the right direction it is necessary that the pressure in the flow main at the point of junction with the flow riser be higher than the pressure at the corresponding point in the return main. If the pressure in the return main is higher the radiator will start backward. It will also be sluggish and never really hot.

It is very important, then, to keep the pressure in the flow main higher than the pressure in the return main. The cool, heavy water in the return header tends to force water into the bottom of the heater and out of the top, producing the desired higher pressure in the flow main.

As to the radiator, the cool, heavy water is flowing directly into the return main, thereby tending to increase the pressure in exactly the wrong place. The conclusion is, therefore, that except for its own particular circuit, the pressure head generated in a radiator and its risers, instead of helping circulation, is a disturbing influence.

The problem of insuring good circulation is two-fold:

1. The resistance of the mains must be low enough that the heater pressure head alone is great enough not only to overcome all the friction in the mains, but also to leave a surplus large enough to insure that throughout the entire length of every line the pressure in the flow main shall be higher than the corresponding pressure in the return main.

2. The friction head in every radiator circuit must be great enough not only to absorb all its own pressure head, but also to absorb, in addition, a pressure head equal to the difference in pressure between the mains at the points where its risers join the mains.

Abstracted from a paper by E. G. Smith presented at the annual meeting of the A.S.H.V.E.

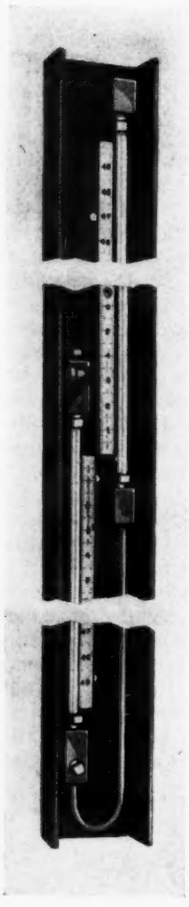
✦

WHILE THE VALUE OF EXPORTS of electrical machinery and apparatus in February, $10,072,224, exceeded by more than $1,000,000 the value of exports in February of last year, there was a decrease of $1,342,000 as compared with January. The movement, however, compares favorably with the monthly average of such exports in 1929, which was $10,113,784. There were a number of items showing decided increases over February of last year. Some of them are: steam generator sets, transformers, rectifiers, converters, transmission apparatus, and instruments.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Special U-Tube Mercury Manometer



Manometer with 100-in. scale

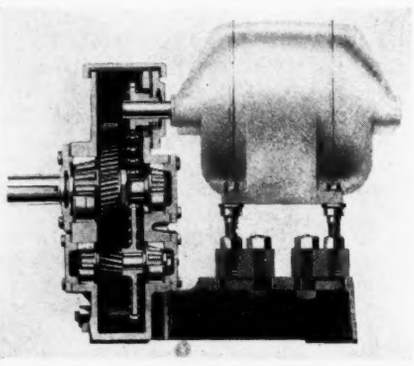
THE illustration shows a special type of U-tube mercury column manometer designed to measure pressures up to 50 lb. It can also be furnished suitable for measuring differentials on line pressures up to 500 lb. The special construction shown is designed to eliminate the difficulty sometimes met with in attaching large precision instruments of this kind to the connecting pipes.

Since the principle of a manometer depends upon the difference of liquid level in the two arms of the U-tube produced by the difference of pressure between the two ends of the tube, the arms must in this case be about 100 in. high. Therefore, to permit the manometer connecting union on the pressure side to be brought out at the middle instead of the top of the instrument, the upper part of one of the arms is omitted, and the pressure tube is connected to a point a little above the normal zero line of the liquid. The other arm of the tube, being open to the atmosphere, needs no pipe attachment. The instrument is put out by the Meriam Company, Cleveland, Ohio.

Improved Speed Reducer Unit

CHIEF among the improvements recently made to the speed reducer manufactured by the Cullman Wheel Company, 1346 Altgeld St., Chicago, Ill., which was illustrated and described in the Oct. 28, 1928, number of *Power*, are the substitution of roller bearings for phosphor bronze bearings and the use of helical in place of spur gears.

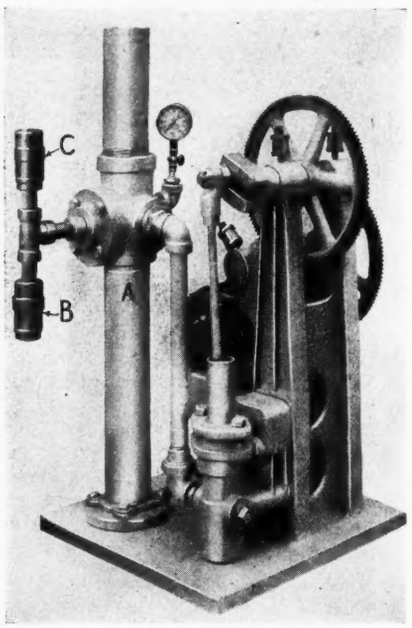
Sprockets and roller chain for the first reduction from two to six times that of the motor speed have been retained. Some changes have been made in the oiling arrangement at the main gear bearing and where the motor shaft enters the reducer. At the latter point the hub of the sprocket has been extended into the oil chamber, replacing the ring formerly used. All parts are lubricated by spray from the sprocket chain. Over-all dimensions remain the same.



Improved speed reducer roller bearings

New Hydro-Acid Pump

IN THE illustration is shown a new hydro-acid pump developed by the Paige & Jones Chemical Company, Inc., Hammond, Ind. It is built in capacities of 60, 150, and 300 gal. per minute and in larger sizes on special orders. It will handle any acid in concentrations not injurious to rubber. Acid comes in contact only with hard rubber fittings and a pure gum rubber sack contained in the cylinder *A* shown at the left. A plunger pump driven by a geared motor at 50 r.p.m. furnishes pressure and suction impulses through the medium of water or any suitable liquid to the outside of the sack contained within the cylinder at the left. By this squeezing and suction action the sack pumps the acid in through the lower hard-rubber check valve *B* and out through the hard-rubber check valve *C* above it. Stroke of the plunger pump is adjustable to any desired capacity less than maximum.



Hydro-acid pump

The pressure is practically equal on both sides of the rubber sack, although the sack is capable of withstanding a differential pressure of 10 lb. The pressure at which the whole apparatus can operate is determined only by the hard-rubber fittings, which are capable of withstanding a pressure of 125 pounds.

Attention is called to the fact that unless there should be leakage in the hard rubber fittings at the extreme left, there is no possibility of acid drip, since there is no stuffing box in the acid portion of the pump and no wearing parts outside of the check

valves. By taking out the four cap screws shown in the flange on the cylinder, the entire acid portion of the pump may be lifted out for inspection and repair. Elimination of air and its replacement with water or the hydraulic solution, caused through leakage of the hydro plunger pump, is provided for in the upper portion of the cylinder *A*.

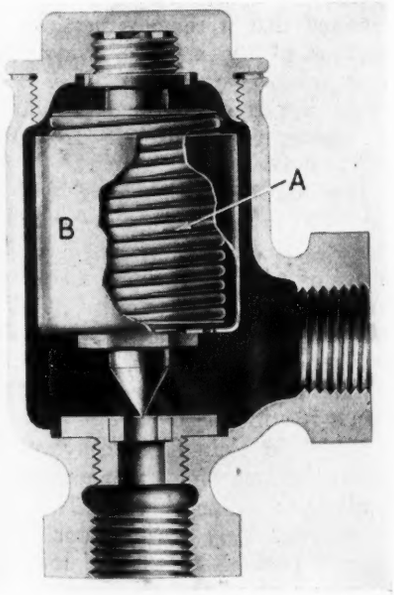
The pump is also built in another model to mount on a mixing tank or on a vat in such a way that the pump may be driven off an eccentric on the horizontal shaft operating the agitator within the tank. The acid portion, together with the cylinder at *A*, can be furnished to attach to any pump of suitable capacity, between the pump and the check valve. All models are self-priming.

Improved Bellows-Type Trap

LONGER BELLOWS, protective shielding, and a self-centering valve head constitute important improvements made recently to the No. 9 steam trap put out by Sarco Company, Inc., 183 Madison Ave., New York City.

Four corrugations have been added to the bellows' helical tubing, distributing the movement of the bellows over a total of fourteen corrugations. The thermo-sensitive element *A* is now incased by a heavy brass shield *B* which protects it against damage by water hammer and impurities in the steam. Self-centering of the valve has been accomplished by providing sufficient flexibility in the bellows to permit the valve head to move freely and center readily under pressure of the bellows. Valve head and seat are made of Monel metal.

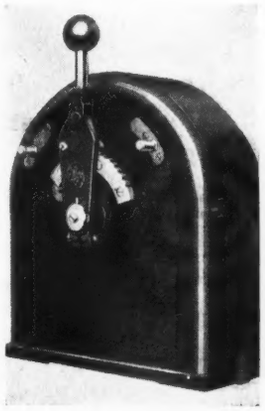
This freedom of movement insures a tightly closing valve and obviates possibility of the valve's sticking off center and allowing steam to wire-draw when the valve is nearly closed.



Cut-away view of trap

Master Switch for Controlling Operation of Magnetic Contactor Controller

A NEW master switch, the function of which is to regulate the control circuits of a magnetic-contactor controller as used on cranes, hoists, and other applications where full speed control from the master

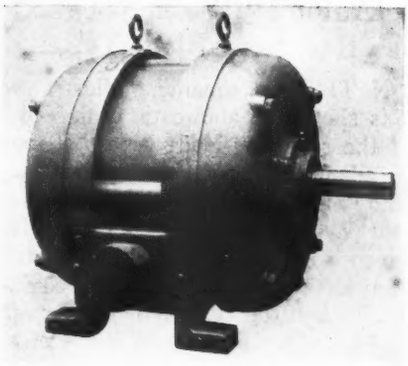


Improved master switch

switch is desired, is announced by the Electric Controller & Manufacturing Company, 2700 East 79th St., Cleveland, Ohio.

Design of the switch incorporates certain refinements, among which are frictionless operation due to the use of ball bearings; short-throw operating handle; absence of gears, contact fingers riding on uninterrupted plane surface; and an accurately machined, notched track, on which an improved roller-type centering device rides. The width of the switch has also been made as small as possible, so that when several of them are mounted in a crane cage they are within convenient reach of the operator.

Built to give a maximum of six points of speed control in each direction with overload reset at the "off" position, the switches for 4, 5 or 6 points of speed control are identical, the only difference being the location of the arm stops. Since the stops are merely screwed into the main frame, they can readily be changed in the field to provide any one of these number of points of speed control.



Cleveland semi-inclosed motor

Improved Design Semi-Inclosed Motor

IN THE improved semi-inclosed motor recently brought out by the Cleveland Electric Motor Company, Cleveland, Ohio, the ventilating system has been redesigned and changes have been made in the construction of bearing brackets, fans and end rings.

Baffles on the bearing brackets direct the air around the stator windings, and the end bells are so designed that the air-current leaves the motor in an almost horizontal direction and sweeps over the outer face of the stator laminations. The outside flanges of the end rings are carried out some distance over the lamination to prevent dirt falling into the air passages or otherwise interfering with the air circulation.

The new construction is now furnished as standard in squirrel-cage and slip-ring motors, both of the ball-bearing and sleeve-bearing types, for general purpose multi-speed or elevator applications. In a modified form it is also used for fan-cooled totally inclosed motors.

An important claim made for this motor is that it can be used on either 2- or 3-phase without any magnetic hum.

Stainless Steel Lock Washers

LOCK WASHERS of stainless steel in any size or section have been made available by the Reliance Manufacturing Company, Massillon Ohio. It is claimed that in addition to having all the qualities of a non-corrosive stainless steel they are of a spring temper equal to that of the ordinary steel lock washer. Stainless steels in coils; or straightened and cut to length in any small-section round, flat, square or hexagon are also available.

Automatic Stoker of the Revolving Blade Type

IN THE accompanying illustration is shown an automatic coal feeder of the revolving-blade type that may be adapted to any shaking grate already installed or provided as an integral part of the stoker. This device, which is especially adaptable to Dutch oven settings, has been developed recently by the Chicago Automatic Stoker Corporation, 1217 West Monroe St., Chicago. It is simple in operation. Coal is shoveled into a hopper of about 400 lb. capacity, from which it is fed by gravity to a pusher box. The pusher receives its motion from an eccentric on the main shaft, which functions through a tapered wedge or arm on the cross shaft that imparts the motion to the pusher.

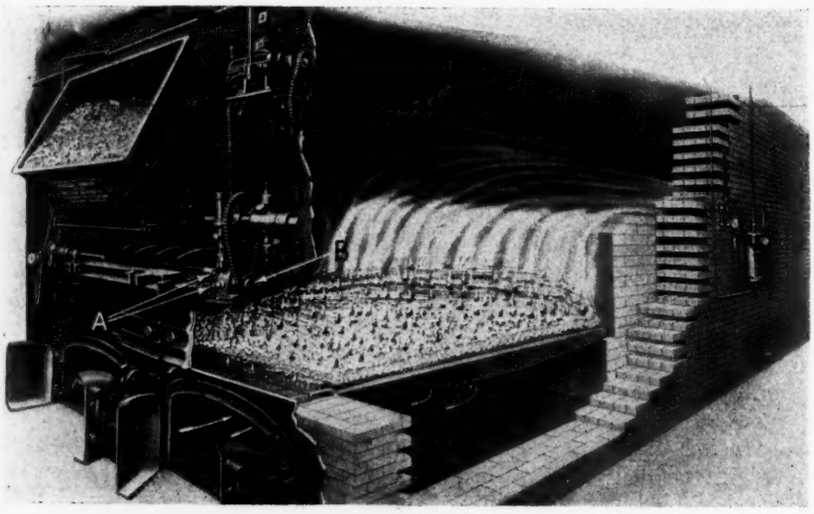
Although the stroke of the eccentric rod is constant, a varying stroke is imparted to the pusher, to meet changing demands for fuel, through the medium of a steam pressure regulator which raises or lowers the wedge. Such action changes the point of contact of the eccentric rod and thus varies its effective stroke. Simultaneously, the regulator adjusts the draft to the new conditions.

By the pusher the coal is passed into a housing below the hopper, and from this point is distributed over the entire grate surface by an adjustable reel looosely fitted with four rows of heavy cast-iron blades. The reel is formed by four blade shafts spaced 90 deg. apart on a circle concentric to the main stoker shaft. Two of the four shafts are indicated at *A*. Every other shaft has right-hand blades, and the alternate shafts have left-hand blades. On each shaft the angles of the blades vary as well, so that each blade serves a particular area of the grate. The blades are loose on their respective shafts, so that as the reel rotates, they are held out by centrifugal force. With this arrangement the four sets of blades function every revolution of the reel and serve to maintain a practically continuous feed and a thin, even fuel bed regardless of load conditions.

Reference to the illustration will show that while the stoker is entirely outside the boiler front, so that all working parts are readily accessible, it requires no floor space in front of the boiler. The drive is an adjustable speed ½-hp. motor connected through roller chains to the main shaft, which, in turn, chain drives the reel shaft *B* on one side of the coal hopper, and on the other side drives the pusher box shaft. The speed of the main shaft is 110 r.p.m. and that of the reel shaft about 300 revolutions per minute.

Integral with the stoker is a set of full-sized firing doors which permit the firing of byproducts or serve as a factor of safety against shutdown, as the boiler always can be fired by hand in case of emergency.

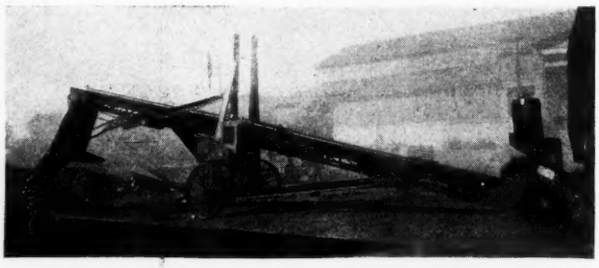
A special front and dead plate is furnished with each stoker. The dead plate contains special tuyères through which overfire air may be admitted, or when forcing the boiler the dead plate may be used as active grate area. Another feature is a hinged coal hopper which may be lowered when cleaning the flues.



Automatic stoker is applicable to any shaking grate

New Drag-Type Flight Conveyors

THE Barber-Greene Company, of Aurora, Illinois, has recently added to its line of coal-handling equipment two new drag-type machines, models 55 and 56 plain flight conveyors.



Model 55 flight conveyor with a coal handling capacity of a ton a minute

Model 55, with a handling capacity of a ton of coal a minute, embodies several new features. The boom is sectional in construction, and the machine may be had in boom lengths of 24, 30, and 39 ft. Flights are deep and cupped to enable them to exert a digging action, and the chain of the flight line is constructed with specially wide wearing surfaces. The truck is built with swivel wheels which allow the machine to build much larger storage piles without moving the actual feeding point. Mounted on the truck is the power unit—either an 8-hp. LeRoi gasoline engine or an 1,800-r.p.m. electric motor. It is so mounted that it remains vertical regardless of the angle at which the truck may be operating. This feature offers the additional advantage of keeping vibration away from the conveyor boom.

The conveyor is equipped with a power boom hoist of the self-locking worm type, which is engaged by means of a hand lever near the power unit. It is possible to raise the discharge end of the machine with the heightening of the pile, so that the coal need never fall a distance greater than a few inches.

Model 56 plain flight conveyor is a smaller machine, the maximum available boom length being 24 ft. It is powered by electric motor only, and the boom is raised and lowered by means of a hand winch and spur gear mounted on the truck.

NEWS of the FIELD

Spot News

REORGANIZATION *of the Federal Power Commission was approved by the Senate on May 12 when it unanimously passed Senator Couzen's bill to create a new body consisting of three members appointed by the President with the confirmation of the Senate. The members will serve for six years at salaries of $10,000 a year. The bill now goes to the House for approval.*

CONSTRUCTION *of a hydro-electric plant with a capacity in excess of 120,000 hp. on the Cedar River near Muscatine, Iowa, is planned by the Federal Construction Company, according to a petition filed on May 13 with the State Board of Conservation.*

CHRISTENED *"Golden Jubilee," a 25,000-kw. turbine-generator was placed in operation recently at the Omaha steam plant of the Nebraska Power Company. The new addition increases the capacity of the station to more than 100,000 kilowatts.*

AMONG THE NOVEL FEATURES *planned for the 63-story office building to be erected by Henry L. Doherty & Company in the financial district of New York City are double-deck elevators which will take on and discharge passengers on two floors at the same time. This will be the first use of this type of elevator.*

AUTHORITY *has been granted by the California Railroad Commission to the Pacific Gas & Electric Company to issue 1,825,000 shares of its common stock at par value of $45,625,000 to acquire controlling interest in the Great Western Power, San Joaquin, and Midland Counties companies in conformity with their agreement of March 29.*

Aluminum Company's Hydro-Electric Plant at Calderwood, Tenn., Now Operating

Development comprises 230-ft. dam, ½-mile tunnel and powerhouse with installed capacity of 112,000 horsepower

AFTER 2½ years of construction work, the new Calderwood hydro-electric plant of the Aluminum Company of America, located on Little Tennessee River at Calderwood, Tenn., has been put in operation at full load, thus rendering available for the manufacture of aluminum 112,000 additional horsepower at the company's Alcoa (Tenn.) works.

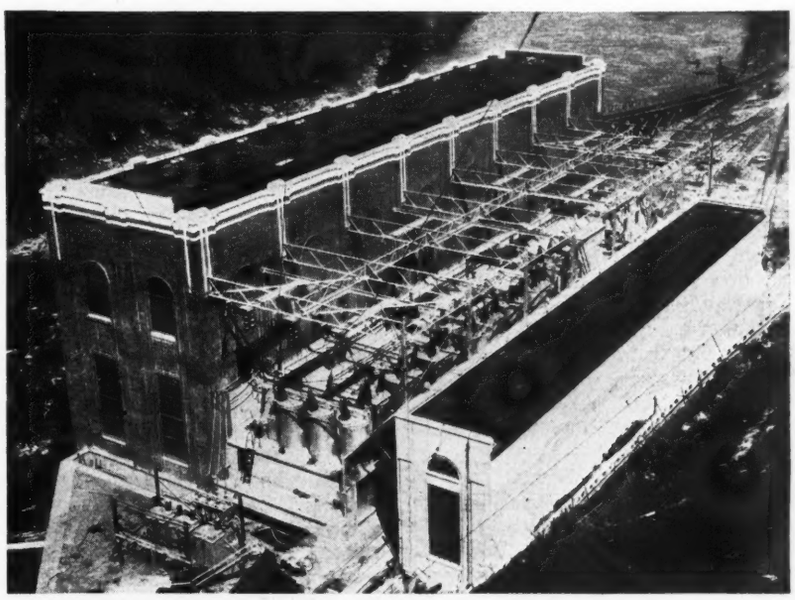
The development comprises a dam 230 ft. high, measured from the lowest point of its foundation, a tunnel ½ mile in length and 26 ft. in diameter and a power house with two 56,000-hp. units operating under a head of 213 ft. Space is provided for the future installation of a third unit of like capacity.

Within 48 hours after the closure gates in the dam were shut, the impounded water had risen above the sill of the intake and had filled the tunnel. The various hydraulic units in the plant were then tested and the turbine-generators started from the switchboard. Seventeen hours later each unit carried its full load of 40,000 kw. under the head then available, with all equipment functioning perfectly. Leakage past the dam was negligible, being less than 0.25 second feet.

The new plant is connected with the 154,000-volt transmission line of the Knoxville Power Company, already in service, carrying power from the Cheoah and Santeetlah Developments to the reduction and fabrication works of the Aluminum Company at Alcoa.

The butterfly valves in the penstock ahead of the turbines, the hydro-turbines and the governors were built by Allis-Chalmers Manufacturing Company, the generators and transformers are products of Westinghouse Electric & Manufacturing Company, and the switchboards and circuit breakers were furnished by General Electric Company. Aluminum is used throughout the plant for busbars.

The Calderwood plant was built by the Aluminum Company's forces under the direction of James W. Rickey, chief hydraulic engineer and T. J. Bostwick, chief electrical engineer. Field supervision was in charge of J. E. S. Thorpe until he became president of Nantahala Power & Light Company in September, 1929, when he was succeeded by I. G. Calderwood, for whom the plant was named.



Powerhouse of Calderwood Hydro-Electric Development

Improvement of Capitol Power Plant Considered by House Committee

Underfeed stokers to eliminate smoke nuisance—Rejection of low turbine bid discussed—New central heating plant proposed

OPERATING EXPENSES of the Capitol power plant which supplies the Capitol and surrounding government buildings with heat and power, are put at $347,390 for the fiscal year of 1931 in the legislative appropriation bill. This measure is now being considered by the House and the expectations are that it will pass without major amendments. During the discussion of the items pertaining to the power plant in the appropriations committee particular attention was placed on the matter of eliminating smoke nuisance.

It was explained to committee members that steps being taken to complete the installation of underfeed stokers under the last eight boilers will go a long way toward eliminating complaints about the violations of the smoke ordinance. Improvements in the coal-burning equipment and boiler plant were begun 5 years ago at a cost of $120,000. At this time, one-half of the older type natural-draft overfeed stokers were replaced by modern forced-draft underfeed stokers. From the standpoint of smoke production, this change has improved conditions considerably, it is stated.

Government engineers explained to the commitee that the steady increase in the load on the boiler plant has made it necessary to replace the remaining half of the old stokers with modern equipment. Until this program is completed some time during the late fall, the plant will have to operate under trying conditions which will make it impossible to avoid the occasional emission of smoke, the committee was informed.

THE ACTION of government engineers in rejecting a low bid for the installation of a new turbine-generator in the power plant, came in for lengthy discussion during the hearings. Members of the committee made the statement that protests have been received over the manner in which the bidding was handled. During the testimony it was brought out that bids were opened on Feb. 5 for the installation of a turbine-generator of 2,000-kw. capacity. A fund of $190,000 was available to pay for the apparatus. Bids were received from the Westinghouse company, the DeLaval Steam Turbine Company, and the Industrial Power Equipment Company.

Despite the fact that the Westinghouse company was the low bidder, officials in charge of the work accepted the bid of the DeLaval Company, on the grounds that the Westinghouse apparatus did not conform to specifications. When the matter was protested to the Comptroller General, a ruling was handed down sustaining the action of the power plant officials. Government engineers told the committee that the specifications called for a generator with a capacity to run 25 per cent overload for two hours. The Westinghouse Company offered a generator of 6,250-kilovolts capacity maximum and no overload rate, they stated.

The committee was informed by the government engineers that the gears which were offered by the Westinghouse company were of a type that would make an excessive noise in operation.

DESIRABILITY of providing a central heating plant for the new group of buildings authorized for the Department of Agriculture, is being considered by government engineers. In the latest building bill submitted to Congress by the President, $85,000 is provided for enlarging and extending the existing power plant used for the Department of Agriculture buildings. The question of whether or not this expansion will be made sufficiently extensive to take care of the new group of buildings is being studied by government technical men.

Engineering reports on the matter of a heating plant of such size as would be needed for so many building raise the point of diminishing economy. Up to a certain distance, it is pointed out, it has proved economical to provide steam heat from a central heating plant. Beyond that distance, however, it is believed that a central heating plant will not prove itself sufficiently efficient to justify its construction.

Hydraulic Laboratory Bill Signed by Pres. Hoover

After eight years of effort on behalf of the engineering profession, the bill providing for the establishment of a national hydraulic laboratory in the Bureau of Standards became a law May 14 with the signature of President Hoover. As passed the bill authorizes an initial expenditure of $350,000 for the construction and equipment of a laboratory "for the determination of fundamental data useful in hydraulic research relating to the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories."

The bill provides that no research on problems under the jurisdiction of other government departments or agencies shall be undertaken by the laboratory without the written authorization of the heads of such departments or agencies. It further provides that any state or political subdivision may call on the laboratory for help in the solution of a hydraulic problem under its jurisdiction.

Reviewing the history of the measure, it was first introduced by Senator Ransdell, of Louisiana, Sept. 8, 1922, at the suggestion of John R. Freeman, eminent civil engineer who has specialized in hydraulics for more than 50 years. Extended hearings were held in Sept., 1922, and in Jan., 1923. It was reintroduced in the 68th Congress and further hearings were held in May, 1924. In the 70th Congress Senator Ransdell reintroduced this measure and at his suggestion Representative O'Connor, of Louisiana, introduced it in the House. This bill passed the Senate April 13, 1928, but after full hearings in the House Rivers and Harbors Committee, it failed to pass, owing to the strong opposition of General Jadwin, then Chief of Engineers of the Army, and other officers of the Corps of Engineers.

On Jan. 6, 1930, in the 71st Congress, Senator Ransdell again presented his measure and Representative O'Connor reintroduced it in the House. Senator Ransdell's measure passed the Senate April 7. In the meantime Mr. O'Connor's bill, which had the cordial support of General Brown, successor to General Jadwin, had been reported favorably and passed the House April 9. After going to conference between the two houses over minor amendments, the bill was finally sent to President Hoover for approval.

A.S.T.M. to Meet June 23-27 at Atlantic City, N. J.

The American Society for Testing Materials will hold its 33rd annual meeting at Chalfonte-Haddon Hall in Atlantic City, N. J., on June 23 to 27. Sixteen sessions and many committee meetings are scheduled on the program, together with the usual recreational features.

Reports and papers of interest to power engineers include: Report of the Joint Research Committee of the A.S.M.E. and A.S.T.M. on Effect of Temperatures on the Properties of Metals, given by H. J. French, chairman, at the second session on Tuesday evening, June 24; "Recent Improvements in Iron-Nickel-Chromium Alloys," presented by N. B. Pilling at the fourth session on Wednesday morning; Report of the Research Committee on Fatigue of Metals, by H. F. Moore, chairman; "A Note on Fatigue Tests on Nitrided Steels," by N. L. Mochel, and Report of Committee A-5 on Corrosion of Iron and Steel, by J. H. Gibboney, chairman, at the eighth session on Thursday morning; and the Report of Committee C-8 on Refractories, by G. A. Bole, chairman, at the ninth session on Thursday.

For the entertainment of those attending the meeting, the annual golf and tennis tournaments will be held.

W.P.C. American Committee to Move to New York

Headquarters of the American Committee of the World Power Conference on July 1 will be moved from Washington to New York. In New York the committee will occupy Suite 1419 in the Chrysler Building. A year's experience with the offices of the committee in Washington has demonstrated that greater efficiency can be secured by having headquarters in New York where it will be more accessible to those having dealings with the committee.

O. C. Merrill, chairman of the committee, will sail for France May 23. He goes first to Paris to confer with the members of the International Commission on Large Dams. Then he will proceed to Berlin to complete preparations for the assembly of the conference June 16. The American delegation will sail from New York June 4. Since the announcement of the list of the American delegates, the names of Samuel Insull and Howard I. Smith have been added.

Reports to Mr. Merrill indicate that attendance at the Berlin conference will exceed 4,000, whereas only 1,700 delegates attended the 1924 conference at London. He expects that the discussions of the economics of power development will be particularly helpful to Austria and the Balkans, where large extension of power facilities are in prospect.

Inquiry Committee Reports on Indian Project

The Committee of Inquiry appointed by the Punjab Government, India, has just issued its report on the progress of the Uhl River (Mandi State) hydro-electric project. The committee does not recommend the abandonment of the scheme in view of the expenditure and large commitments already entered into. The supply of power to the public should, it is considered, begin not later than the end of July, 1933. It is estimated that the ultimate cost will be about $23,440,000 instead of $16,000,000, as originally calculated.

The determining factor, however, for both the date of completion and the final cost must necessarily be the progress made in boring the tunnel through the Himalayan ridge between Uhl and the Beas, by which the water of the Uhl will be carried for 2½ miles through the mountain and then dropped 1,800 ft. down the hillside to a power house beside the Beas. It is recommended that before extending the project to its second stage (an increase by means of additional storage, pipes, and plant to raise the power generated from 36,000 kw. to over 70,000) an expert committee should be appointed to examine the merits of the extension compared with generation of power from canal falls and fuel-driven plants.

The committee was appointed in November, 1929, to report the maximum period in which the project is likely to be completed, the ultimate cost involved, and the return expected on the capital expenditure; the possibility of reduction in expenditure without affecting the efficiency of the development and the means for utilizing the power generated to the fullest extent and best advantage. The report states that current will be distributed by a "grid" of lines spread over the foot of the hills to the Jhelum River in the north of the Punjab and to Delhi in the south. It will supply many small towns and villages with power and will greatly assist a number of mines and factories.

Cheat River Plant Opposed in West Virginia

Opposition to the Cheat River power development proposed by the West Virginia Power & Transmission Company was expressed at a recent hearing before the public service commission by a former governor of the State, A. B. White, of Parkersburg, on the ground that the water power would displace 12,000,000 tons of coal annually.

Steam-driven generating plants are more than adequate to supply the needs of West Virginia, Mr. White asserted, and added that the pending proposition "is primarily to supplement some subsidiary companies in western Pennsylvania and Maryland, where there is an enormous demand for electricity and tremendous variation of the peak load." He said, however, that this statement was not made as an argument against the proposition.

Illinois Industry Gets First Natural Gas

The first natural gas transported by pipe line to Illinois now is being sold mainly for industrial purposes in East St. Louis, it was announced orally at the office of the Illinois commerce commission, according to a dispatch in the *United States Daily*.

It is understood, also, it was stated, that certain surveys are being made and other preliminary work done for the construction of natural gas-pipe lines from the Louisiana or Texas and Oklahoma fields to and through Illinois.

Plans of the Missouri-Kansas Pipe Line Company were said to contemplate a 930-mile gas line from Amarillo, Tex., to the central part of Indiana, passing through Illinois, at a cost of nearly $40,000,000.

The gas now being sold in the East St. Louis district, it was stated, is transported from the Louisiana fields by the Mississippi River Fuel Corporation and distributed by the Cahokia Manufacturers Gas Company, a subsidiary of the Illinois Power & Light Corporation.

News of Canada

West Kootenay gains control of Pend d'Oreille—New Diesel dredge for Montreal company—To survey Cheakamus —New plant for Regina

THE WATER BOARD of British Columbia has granted to the West Kootenay Power and Light Company, Rossland, B. C., the right to proceed at once with surveys for the construction of a 150-ft. dam near the mouth of the Pend Oreille River. The company already has the right to erect a 155-ft. dam further up the river. This second concession virtually gives the company control of the stream. Objections which had been filed by the Reeves McDonald Mining Company were overruled. Opportunity will be given to the latter company, however, to file further objections when both plans are submitted.

The West Kootenay company is a subsidiary of the Consolidated Mining and Smelting Company of Canada which requires a large amount of power for the new fertilizer plant under construction at Trail, B. C. The proposals of the West Kootenay company envisage the development of upwards of 300,000 hp. of electrical energy from the water powers of the Pend d'Oreille, conveniently situated a few miles southeast of Trail. This river enters Canada from the United States, traversing about 17 miles of Canadian territory before joining the Columbia River. It is on this seventeen miles of river that there is a huge concentration of water power available for hydro-electric development.

THAT APPLICATION of Diesel engine power to industrial work is growing apace, is exemplified in Canada by the new hydraulic dredge being built at Sorel, Que., by the Manseau Shipyards, Ltd., for the General Dredging Contractors, Ltd., of Montreal. The new dredge will generate its own electricity. The power plant will consist of four 700-hp., 8-cylinder M.A.N. Diesel engines, each directly connected to a 400-kw., 250-volt d.c. generator. There will also be an auxiliary generator set of 95 hp. It is interesting to note that the engines being used in the operation of this dredge are the same as those used for the auxiliary power on the two new German super-liners, Bremen and Europa.

All electrical equipment is being supplied by the Canadian General Electric Company, and most of it is being built at Peterborough, Ont. With the exception of the Diesel engines, all other equipment used in the vessel is being manufactured in Canadian shops.

SURVEY of the possibilities of hydro-electric development of the Cheakamus River and its tributaries will be undertaken immediately by the city of Vancouver, B. C., according to Commissioner E. A. Cleveland, who has been

appointed in charge of the work. The commissioner has just completed a trip through a large portion of the territory, making preliminary arrangements for sending survey parties into the country.

CONSTRUCTION has been commenced by the Dominion Electric Power, Ltd., of Regina, Saskatchewan, on a new power plant, two miles east of Estevan, Saskatchewan, to cost approximately $350,000. With an initial capacity of 2,000 kw., the plant will be designed for unlimited expansion, and it is thought that a substantial addition will be required within the next two or three years. Building operations are in charge of George Rodemeyer, Dominion Electric's construction superintendent, of New York.

To Finance Diesel and Gas Engine Sales

An exclusive contract has been signed by Commercial Investment Trust, Inc., New York, with the Cooper-Bessemer Corporation, Mount Vernon, Ohio, one of the largest manufacturers of internal-combustion engines, for financing the sales of Diesel and gas engines on a time-payment plan. This contract is one of a number of similar arrangements recently made by C.I.T., and forms an interesting example of the increasing use being made by heavy industrial equipment manufacturers of finance company service in promotion of sales in the industrial field by enabling purchasers such as municipalities, industrial plants, mining companies, and other users to pay for income-producing equipment out of income or savings realized.

Volume of Business Approaches 1929

For the first time this year the volume of general business during the week ending May 7 as indicated by check payments approximates the volume reported for the same week in 1929, and in some of the sections of the country exceeded last year's volume. Not only did the volume of business during this week in the country as a whole fall short of last year by less than one-half of one per cent, but it exceeded the average business during the previous four weeks by 15 per cent, and the previous twelve weeks by 23 per cent. The trend in business operations has been definitely upward since the middle of April.

General manufacturing, as indicated by the monthly consumption of electrical energy for power purposes, also appears to be on a definite upward trend. The rate of April manufacturing operations remained at substantially the same level as during March, although a seasonal drop in operations would normally be expected to take place during April. Current operations are still, however, some 11.9 per cent under April, 1929.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual meeting at Skytop Lodge, Cresco, Pa., May 26-28. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Order of Steam Engineers. Annual convention and mechanical exhibit at the Grand Fraternity Building, 1626 Arch St., Philadelphia, Pa., June 9-12. Secretary, William S. Wetzler, 6033 Jefferson St., Philadelphia, Pa.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Chattanooga, Tenn., June 17-19. Secretary, C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio.

National District Heating Association. Annual convention at the Coronado Hotel, St. Louis, Mo., June 3-6. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Personals

D. M. MEDCALF was guest of honor May 5 at a dinner tendered him by delegates to the interprovincial convention of the Canadian Boiler Code Committee at Calgary, Alberta, to mark his 25th anniversay as chief boiler inspector for the Province of Ontario. During the convention, Mr. Medcalf presided at the technical sessions.

H. HOBART PORTER, chairman of the Engineering Foundation and president of the American Water Works & Electric Company, has just returned from a cruise around the world aboard the Columbus. Mr. Porter has been away since the middle of February.

L. E. MERROW has resigned as chief engineer of the Green Mountain Power Corporation, Burlington, Vt., to join the engineering staff of the New England Public Service Company with headquarters at Augusta, Me. Mr. Merrow joined the Montpelier & Barre (Vt.) Light & Power Company's organization in 1923, soon becoming general superintendent. More recently he has been assistant to the general manager of the Green Mountain Power Corporation, following the consolidation of the Burlington Light & Power Company and the Montpelier & Barre company.

FARLEY OSGOOD, consulting engineer of New York and a past-president of the American Institute of Electrical Engineers, has been elected a vice-president and director of the Security Distributors Corporation, New York.

W. L. LOCKE, vice-president of Stone & Webster Engineering Corporation, has prepared a water-power paper for the World Power Conference. The paper, which will be presented at the Berlin meeting, deals with many interesting features in the construction of the 378,000-hp. hydro-electric development on the Susquehanna River in Maryland. The ultimate development of this plant will be 594,000 hp.

E. A. CLARK, of the Philadelphia office of the Reliance Electric & Engineering Company, has been advanced to the engineering department in Cleveland where he will be engaged in the design of direct current motors.

E. R. MELLENGER has resigned from Diesel Power, Ltd., Toronto, Canada, to become manager of the Diesel engine division of Collingwood Shipyards, Ltd. His headquarters will be in Toronto. Mr. Mellenger had been with Diesel Power, Ltd., for nearly four years, first as chief engineer and later as manager.

CLYDE C. WHIPPLE, assistant professor of electrical engineering at the Polytechnic Institute of Brooklyn, has been granted leave of absence for one year by the corporation of the Institute to serve as visiting professor in electrical engineering at the Green School of Engineering of Princeton University.

Business Notes

HILL CLUTCH MACHINE AN FOUNDRY COMPANY, Cleveland Ohio, announces the re-opening of its New York office with A. L. Whiteside in charge.

STANLEY ELECTRIC TOOL COMPANY, subsidiary of the Stanley Works, New Britain, Conn., has purchased the trade name, stock, tools, jigs, fixtures, etc., of the Unishear Company, 270 Lafayette St., New York City and will continue the manufacture and development of these machines.

TERRY STEAM TURBINE COMPANY, Hartford, Conn., announces the appointment of T. G. Hart to the position of general sales manager. Mr. Hart has been associated with this company since 1919 and for several years has been manager of its Chicago office.

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, have elected Robert W. Gillispie president and general manager. The former president, Robert H. Jeffrey, has been made chairman of the board.

SHELL OIL COMPANY, San Francisco, Calif., has announced the removal of its headquarters to the Shell Building, San Francisco. This building has recently been completed and dedicated.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., announces the addition of Albert Shaw to its Salt Lake branch office sales force. Mr. Shaw will specialize on coal and metal mining industries throughout the Salt Lake branch office district.

H. D. CONKEY & COMPANY, Mendota, Ill., announce that they have changed the name of their manufacturing division from H. D. Conkey & Company to Conco Crane & Engineering Works, division of H. D. Conkey & Company.

CUTLER-HAMMER, INC., Milwaukee, Wis., has purchased the assets of the Union Electric Manufacturing Company, also of Milwaukee. The branch sales offices and warehouse stocks of Union will be consolidated immediately with the Cutler-Hammer branch offices and warehouses and the present factory of Union will be operated as a manufacturing division of Cutler-Hammer.

NASON MANUFACTURING COMPANY, New York, N. Y., has elected Raymond Seabrook president to succeed his father, the late H. H. Seabrook. The new president was formerly secretary of the company.

STOCKHAM PIPE & FITTINGS COMPANY, Birmingham, Ala., announces the appointment of Germer Petesch as assistant general sales manager. Mr. Petesch has long been associated with the manufacturing end of the business and has also been manager of the Chicago sales office.

With the SOCIETY SECTIONS

A.S.M.E., Boston Section. Inspection trip through the turbine, deep-forging and main motor departments of the Lynn Works of the General Electric Company at 1:30 p.m. on May 23.

A.S.M.E., Indianapolis Section. Joint meeting with the A.I.E.E. at the Hotel Lincoln on May 23 at 6:30 p.m. Subject: "Refinements in Power Plant Design With Special Reference to the Use of Models," by J. H. Walker, assistant chief of research, Detroit Edison Company.

N.E.L.A., East Central Division. Annual convention at the Hotel Statler, Cleveland, Ohio, May 20-23. Secretary, D. L. Gaskill, Greenville, Ohio.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

New York State Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the Niagara Hotel, Niagara Falls, N. Y., June 12-14. Chairman, Walter B. Smith, 482 Portage Road, Niagara Falls, N. Y.

Plant Engineers' Club. Dinner meeting at the University Club, Boston, Mass., on May 21 at 6:30 p.m. Subject: "Welded Power Plant Piping," by R. H. Baker.

Trade Catalogs

MOTORS—The General Electric Company, Schenectady, N. Y., has published the following two folders on motors: GEA-1117, covering solid-shaft, vertical induction motors; and GEA-1202, on Type RKS capacitor motors.

PUMPS—In a condensed yet complete reference book entitled "Pump Guide—No. 12," the Chicago Pump Company, 2336 Wolfram St., Chicago, Ill., shows what pumps are used for the different services and gives engineering data on each pump. One section is devoted to "useful information," which gives tables useful in figuring the capacities of pumps.

DIESEL ENGINES — A new bulletin just gotten out by McIntosh & Seymour Corporation, Auburn, N. Y., discusses Diesel engines in central stations. Among the chapter headings are: Diesel power is logical for many small and medium-size stations, Central location does not annoy the neighbors, Unequalled for auxiliary and standby power, and where and why Diesel power can be combined profitably with steam.

WATER TREATMENT — The research department of the Filtrators Company, 96 Liberty St., New York, N. Y., has printed a leaflet explaining the theory of their non-chemical Filtrator method of feed-water treatment by means of colloids.

CONVEYORS—Applications and operating data on the Nuveyor pneumatic ash conveyor are furnished in Bulletin No. 201 of the United Conveyor Corporation, 37 West Van Buren St., Chicago, Ill.

CONVEYORS—The Stearns Conveyor Company, Cleveland, Ohio, has recently issued a catalog and engineering data book containing complete and specialized information on the designs and application of Rex-Stearns Timken idlers for all types of belt conveyors, together with allied and auxiliary equipment.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @$2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.?0 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—May 15, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—May 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.555 per bbl.; 28@30 deg., $1.655 per bbl.; 30@32 deg., $1.705 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—May 7, f.o.b. local refinery, 30@34 deg., fuel oil, 5.25c. per gal.; 36@40 deg., 5.25@5.5c.

Philadelphia — May 2, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — May 6, tank-car-lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—May 13, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—May 12, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—May 10, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Davis—City is having plans prepared for the construction of two pumping plants in connection with sewage system. J. Lynch, Davis, is engineer.

Calif., Los Angeles — Maurice Feigenbaum, Union Bank Bldg., will build a 12 story apartment building including steam heating system, elevators, etc., at Vine St. and Franklin Ave. Estimated cost $1,000,000. M. Maltzman, 704 Union Bank Bldg., is architect. Work will be done by day labor.

Calif., Los Angeles—State of California, is having plans prepared for the construction of a 12 story office building including steam heating system, elevators, etc., at First and Spring Sts. Estimated cost $1,250,000. J. C. Austin and F. M. Ashley, 608 Chamber of Commerce Bldg., are architects.

Conn., Bridgeport—United Illuminating Co., 1115 Broad St., awarded contract for the construction of a 6,000 v. switching station, to E. Bray Co., 362 River St. Estimated cost to exceed $40,000, including equipment.

Conn., Mansfield — State Bd. of Finance, Hartford, will receive bids until June 6 (extended date), for the construction of dormitories, power plant and laundry at Mansfield State Training School here. Estimated cost $400,000. Towner & Sellew, 363 Main St., Middletown, are architects.

Ill., Springfield—City, c/o W. J. Spaulding, Comr. of Public Property, will receive bids until May 26 for addition to boiler house in connection with power plant improvements. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., are engineers.

Ky., Lexington—June 3, by U. S. Veteran's Bureau, Room 764, Arlington Bldg., Wash., D. C., for constructing and finishing one Coal Bunker and Mechanical Stoker complete, for Veteran's Hospital here.

Minn., St. Paul—Arcade Investment Co., H. Lowry, Pres., 1 Eleventh St. S., Minneapolis, will soon award contract for a 10 story office building, including steam heating system, etc., at 4th St. between Wabasha and St. Peter Sts. Estimated cost $1,000,000. C. H. Johnston, 360 Robert St., St. Paul, is architect.

Miss., Hazlehurst—City plans construction of and equipment for power plant. Estimated cost $55,000.

N. J., Jersey City—Public Service Electric & Gas Co., 80 Park Pl., Newark, is having preliminary plans prepared for the construction of a pumping station at St. Pauls Ave., here. Estimated cost $40,000. Private plans.

N. J., Montclair — Town Comn., plans constructing a pumping station and laying connecting link of pipes to the Wanaque aqueduct. Estimated cost $50,000. Metcalf && Eddy, 1300 Statler Bldg., Boston, Mass., consult. engrs.

N. J., Trenton—City Comn., plans to install two electrically driven pumps at pumping station, 20,000,000 capacity each. Estimated $50,000. A. Swan, Trenton, Comr.

N. Y., Albany—New York Power & Light Co., awarded contract for the construction of a service building to J. P. Sewell, 372 Hudson Ave. Estimated cost $450,000.

O., Cleveland—Dept. of Public Welfare, H. H. Griswold, Dir., Ninth and Oak Sts., Columbus, received lowest bid for the construction of a 1 story, 110 x 114 ft. cold storage plant, storeroom, etc., on Turney Rd., also 1 story, 66 x 124 ft. cold storage plant, storeroom, etc., at Hawthornden Farm, Canal Rd. from Melbourne Construction Co., $71,000 and $49,200 respectively; laundry building at Hawthornden Farm Canal Rd. from Dawson & Finan, 1276 West Third St., Cleveland.

Okla., Oklahoma City—P. O. Denham, 701 North Western Ave., plans the construction of a 30 ton raw water ice plant. Estimated cost $50,000. Private plans.

Okla., Wilburton—City is having plans prepared for the construction of a new Diesel engine power plant. Estimated cost $30,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Ore., Portland—R. B. Loyd, awarded contract for the construction of a 24 story hotel at East First, Hassalo, Adams and Multnomah Sts., to L. H. Hoffman. Estimated cost $3,000,000. Steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc., will be installed.

South Dakota — Oacoma Corp., W. Gordon, Sioux City, Ia., Pres., plans the construction of a hydro-electric plant on the Missouri River near Oacoma and Chamberlain to furnish power for manganese mining plant to be operated by General Manganese Corp., Detroit, Mich. This corporation (Manganese) has acquired 200,000 acres of land near Oacoma and Chamberlain and has leased 125,000 acres additional.

Tenn., Chattanooga—V. S. Johnson, granted franchise to construct compressor stations, also natural gas pipe line from Sunbright field to Chattanooga. R. B. Cooke, Attorney, in charge.

Tenn., Jackson—City is having plans prepared for improvements to electric light plant, probably steam plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

Texas — Texas Hydro-Electric Co., Sequin, awarded contract for the construction of a power dam, 90 ft. high, 340 ft. long, 18 ft. at top on Guadalupe River between Sequin and Gonzales to Sumner Sollitt Construction Co., National Bank of Commerce Bldg., San Antonio. Estimated cost $400,000.

Tex., Abilene—West Texas Utilities Co., plans the construction of a steam operated electric power plant near Lytle Creek. Private plans.

Tex., San Antonio—Scobey Fireproof Storage Co., 315 North Medina St., awarded contract for the construction of a cold storage plant at 300 Blk. North Medina St., to McKenzie Construction Co., Travis Bldg. Estimated cost $200,000.

Tex., Sherman—Ice Pool, Greenville, awarded contract for a 1 story, 60 x 75 ft. ice plant at 300 West Houston St., here, to C. C. Mayhew and J. A. Ladd, Sherman. Estimated cost $60,000.

Tex., Stratford — West Texas Utilities Co., Abilene, purchasing municipal water and light plants and plans extensions and improvements including additional large engine unit, transmission line, etc., here. Private plans.

Va., Reusens—Appalachian Power Co., J. E. Jackson, Mgr., Bluefield, plans expending $2,000,000 for extensions and improvements including power lines, enlarging hydro-electric plant from 6,000 to 17,000 hp. here.

Equipment Wanted

Air Compressors, etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until May 26 for automatic air compressors, blowers, reflectors, etc.

Boiler, Engines, etc. — Hood River, Ore. — Hood River Packers Assn., plans to purchase boilers, engines, cooling apparatus, etc., for proposed fruit packing plant.

Boilers, Turbines, Condensers, Stokers, etc.—Jackson, Miss. — City will receive bids until May 28 for boilers, steam turbines, condensers, stokers and coal handling equipment, etc., for proposed electric light plant improvements.

Engine, Switchboard, etc.—Garnett, Kan.—City, G. L. Crum, Clk., plans to purchase a new Diesel engine and switchboard, and possibly new cooling system for proposed power plant improvements.

Generator, Power Units, etc.—Brooklyn, N. Y.—Signal Supply Officer, New York Central Depot, 58th St. and First Ave., will receive bids until June 2 for motor generator, Signal Corps type, m.g. 4; also until June 4 for power units, Signal Corps type, P.E.-41.

Motor—La Verne, Calif.—P. A. Yoder, Clk., will receive bids until May 26 for a 150 hp. motor for waterworks pumping plant.

Power Plant Equipment—Mansfield, Conn.—State Bd. of Finance, State House, Hartford, will receive bids until June 2 for power plant equipment including pumps, turbine generator, switchboard, etc., for Mansfield Training School here.

Pump—Edwardsville, Ill.—Treasury Dept., Office of the Supervising Architect, Washington, D. C., will receive bids until June 12 for sump pump, etc., at U. S. Post Office, here.

Pump — North Reading, Mass. — Dept. of Public Health, State House, Bodgon, plans to purchase a horizontal duplex double action piston power pump at State Sanitorium here.

Pumping Unit — Mountainair, N. M. — City plans to purchase pumping unit, etc., for proposed waterworks system.

Pumping Units—Port Arthur, Tex.—City is receiving bids for pumping units for additional unit of sea wall protection project. Estimated cost $200,000.

Pumps, Motors, etc.—Eugene, Ore.—Water Board, C. H. McClain, Comr., will receive bids about Aug. 7 for pumps, motors, etc., for proposed waterworks improvements. Estimated cost $250,000.

Industrial Projects

Calif., Los Angeles—Cambria Spring Co., 915 Santee St., awarded contract for a 1 and 2 story, 60 x 150 ft. factory at 12th and San Julian Sts., to May & Grimwood, 520 East 8th St.

Calif., San Francisco — Braun-Steeple Co., 1088 Howard St., affiliated with Braun & Co., New York, and Chicago (manufacturers of ornamental iron products), plans the construction of a factory at Potrero Ave. and 18th St. Estimated cost to exceed $40,000.

Conn., Waterbury—Scoville Mfg. Co., 99 Mill St., will soon award contract for the construction of a 3 story, 90 x 300 ft. factory for the manufacture of brass, bronze, aluminum and steel stampings and brass forgings, etc., on Ambrose St. Estimated cost $200,000. H. L. Thompson, 59 North Main St., is architect.

Ill., Chicago—American Can Co., 230 Park Ave., New York, N. Y., will build a 5 story addition to factory at 60th St. and Western Ave. here. Estimated cost $3,000,000. Work will be done by labor and separate ocntracts.

Mo., St. Louis—W. G. Shelton Co., 17th and St. Charles Sts., is having plans prepared for a 3 story factory for the manufacture of marcel waving machines and other electrical devices at Olive and Beaumont Sts. Estimated cost $100,000. A. J. Widmer & Associates, Inc., 1217 Fullerton Bldg., are architects.

N. J., Elizabeth—Thomas & Betts Co., 36 Butler St., manufacturers of electrical supplies, awarded contract for a 3 story, 80 x 180 ft. factory to Morrison & Sherman Inc., 223 Grove St. Estimated cost $100,000.

N. J., Irvington—Helwig Welding Co., 1374 Springfield Ave., awarded contract for the construction of a 1 story, 50 x 110 ft. welding plant at 42-44 Cordier St., to F. D. Trainer & Son Inc., 12 Smith St. Estimtaed cost $40,000.

N. J., Kearny—Western Electric Co., Inc., O. C. Spurling, Lincoln Highway, will not construct factory buildings 40 E, 41 and 42 on Central Ave. $500,000. Project indefinitely in abeyance.

N. Y., Flushing—I. B. Kleinert Rubber Co., 18th St. and 5th Ave., plans a 28 x 50 ft. addition to boiler house at 19th St. and 5th Ave. Estimated cost $40,000. Private plans.

N. Y., New York—Consolidated Gas Co., 4 Irving Pl., is receiving bids for construction of and equipment for water gas plant at Hunts Point. Estimated cost $10,500,000. Contract let for thirty-four coke-gas ovens to Koppers Co., Koppers Bldg., Pittsburgh.

O., Celina—Celina Mfg. Co., awarded contract for a 1 story, 90 x 340 ft. factory for the manufacture of metal products to Hisey & Bebout. Estimated cost $40,000.

O., East Liverpool — Patterson Foundry & Machine Co., plans the construction of a new factory, including electric furnace and electric annealing ovens, etc., on East End St. Estimated cost $50,000. Private plans.

Pa., Homestead—Universal Atlas Cement Co., 208 South La Salle St., Chicago, Ill., awarded contract for a 2 story, 70 x 122 ft. cement warehouse and distribution plant, including bulk unloading building, six tanks, 50 ft. high and 24 in. in diameter, loading platform, conveyors, etc., at West St. and Second Ave., to Rust Engineering Co., 2600 Koppers Bldg. Pittsburgh, Pa. Estimated cost $100,000.

Pa., Monaca—St. Joseph Lead Co., 250 Park Ave., New York, N. Y., awarded contract for a smelter to produce both zinc metal and zinc oxide, using the new electric-thermic process of treating ore here, to United Engineers & Constructors, 112 North Broad St., Philadelphia. Estimated cost $3,000,000.

Va., Covington—Industrial Rayon Corp., H. S. Rivitz, Pres., West 98th St. and Walford Ave., Cleveland, O., will soon award contract for a group of factory buildings, here. Estimated cost $750,000. Christian, Schwarzenberg & Gaede, 1836 Euclid Ave., Cleveland, are architects.

Ont., St. Thomas—St. Thomas Stamping & Enameling Co. Ltd., is having plans prepared for additions and alterations to enameling plant including three new enameling kilns. Estimated cost $100,000. J. T. Findlay, 430 Talbot St., is architect.

Ont., Welland—Page-Hersey Tubes Ltd., 100 Church St., Toronto, is having plans prepared for the construction of a 1 and 2 story plant for the manufacture of tubes, pipes, etc., here. Estimated cost $2,000,000. Private plans.